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GENESEE RIVER BASIN STUDY
VOLUME INDEX
AND
LIST OF APPENDICES

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GENESEE RIVER BASIN

COMPREHENSIVE

STUDY OF

WATER AND RELATED LAND RESOURCES

Volume VI.

APPENDIX J.

AGRICULTURAL STUDIES.

Appendix K.

Sedimentation.

9 Final rept.

12 328p.

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service

Economic Research Service

Forest Service

11 1967

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GENESEE RIVER BASIN

COMPREHENSIVE STUDY OF
WATER AND RELATED LAND RESOURCES

APPENDIX J - AGRICULTURAL STUDIES

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SUMMARY

The objective of the Genesee River Basin Study was to effect an orderly development of the water and related land resources of the Basin. Within this objective, Appendix J, Agricultural Studies, has directed its attention to the upland areas of the Basin. Accomplishment of the objective necessitated the following steps:
1) An inventory of present data and related land resources;
2) a determination of the overall needs for these resources;
3) an evaluation of the potential for meeting these needs; and
4) the formulation of a plan of development for the Basin.

Participation in the study by the Department of Agriculture is under the provisions of Public Law 566 as amended. It was carried out under the Chairmanship of the Buffalo District of the United States Army Corps of Engineers in cooperation with other agencies of the federal government and the states of New York and Pennsylvania.

The Basin is an area of about 2479 square miles, falling into two land resource areas: the Glaciated Allegheny Plateau and Catskill Mountains, characterized by shallow, acid hilltop soils and a dairy-type agriculture and the Ontario-Mohawk Plain with deeper high-lime soils and a strongly diversified agriculture. Also included in this study was the Ontario Lake Plains Service Area, a region of 750 square miles north and west of the Basin lying between Lockport and Rochester. This area was included because of its rich agricultural potential and the possibility of supplying it with irrigation water from the Genesee River Basin via the New York State Barge Canal, which traverses the region from east to west.

Rainfall in the Basin is fairly well distributed throughout the year but in combination with other factors, can cause problems. In spring, rainfall, snowmelt, and low rates of infiltration act to cause high runoff and some degree of flooding on a nearly annual basis. One of the largest sources of damage, the main stem of the Genesee in the populous areas of Rochester has been controlled by the Mt. Morris Dam, constructed by the Corps of Engineers in 1951. Damages in the upstream areas are generally scattered although the Canaseraga Valley has suffered extensively. In those areas investigated by the Department of Agriculture, flood damages were estimated to total about $117,000 annually. Erosion is also a problem which, though critical in local areas, is minor on a Basin-wide basis.

Dry periods in the late summer can and do cause decreased crop yields. Irrigation is currently used on only a small portion of the Basin and the Ontario Lake Plains Service Area. Intensively grown vegetables and potatoes are expected to demand the greatest portion of any irrigation water supply. It is anticipated that irrigation of vegetable crops must increase to a total of about 57,000 acres in the year 2020 if the area is to retain its present share of national and regional production.

The land in the Basin is about 35 percent forested, of which 80 percent is held in private ownership. About 55 percent is in cropland and pasture while the metropolitan areas of Rochester occupy a large portion of the remaining 10 percent of the land in other uses. Due to agricultural trends, it is expected that crop and pasture land will decrease by 35 percent in the year 2020 while forest land and other land uses will increase by 20 percent and 35 percent respectively. Much of the land released by agriculture, as farms adjust to economic conditions, enters into the residential or recreation land market. In 1959, there were an estimated 5279 farms in the Basin having an average investment of $26,750. Only 5 percent of the Basin population is classified as rural farm while 18 percent are rural non-farm.

Projections indicate the supply of agricultural land and labor will be adequate to meet all expected agricultural product needs in the future. Water for normal on-farm use and rural domestic consumption also appears to be adequate to the year 2020 with the exception of several small and isolated instances.

With respect to the forest resources, it is estimated that growth will be sufficient to meet needs expected to the year 2020. At present the rate of removal of favored species, sizes and grades exceeds the rate of replacement and this problem will continue. Water supply will be adequate for forest-based industry in the future unless a major water user were to locate in the southern portion of the Basin.

One of the greatest demands for impounded water in the Basin is to meet the rapidly growing needs for fishing, water fowl habitat for hunting, and for water based recreation. Although the Basin is naturally endowed with many lakes, the limited public access and development of this resource have not met these needs, and a scarcity is projected at an increasing rate into the future. The opportunity for these types of development is available and must be taken.

Pollution has become a significant problem in the Basin at present and one which is continuing to grow. In the upper watersheds, the problem is often caused by food and dairy processors and municipal sewage. Larger industrial firms may in general be cited for pollution of the lower reaches of the Basin.

The availability of a municipal or industrial water supply has not generally been a great deterrent to growth in the Basin although several areas have indicated a current need for additional supplies. Many combinations of surface and ground water are used and it appears that capacity for additional development is available as needed.

Due to the changing character of land use and agriculture, and growing incomes and population, the plan of development proposed by the Department of Agriculture is both diverse and comprehensive. The plan emphasizes land treatment measures on agricultural and forest land which are designed to reduce runoff, erosion, and sediment production and includes sound conservation practices which protect and improve agriculture and the woodlands.

Of the more than 200 structural possibilities investigated in the Genesee River Basin, 34 are proposed for construction. These include three reservoir sites which will provide a measure of flood control and three which will store water for irrigation in the Basin proper. An additional 29 sites are potentially capable of supplying irrigation water in the Ontario Lake Plains Service Area. In total, these irrigation sites will provide water sufficient to irrigate an estimated 14,900 acres of vegetable crop.

One structure is capable of supplying municipal water to a village in the central Basin. The community has made known its interest in the reservoir. According to the Federal Water Pollution Control Administration and the New York State Public Health Service, four structures could provide water quality control in lieu of advance treatment in four of the critically polluted reaches of the Basin. Local, state, and federal action in this area is progressing and should do much to reduce the magnitude of the problem.

With respect to recreation and fish and wildlife needs, 27 of the proposed structures will furnish an estimated 2,663,700 recreation, hunter, and fisherman days annually. They will provide about 5,880 surface acres of water and utilize approximately 4,290 additional acres of land to attempt to meet the expanding demands for these types of facilities.

A list of all structures proposed in this program is shown in Tables J45, J50 and J51 on pages J146, J160 and J161 respectively of the Appendix. The total cost for structural measures is estimated at $32,968,500.

Although all of the irrigation structures in the Ontario Lake Plains Service Area are eligible for construction under P.L. 566, only 5 of the 34 structures in the Basin could be implemented under this legislation. In order to facilitate the portions of the program dealing with single purpose recreation, fish and wildlife, municipal and industrial water supply, and water quality control, basin-wide authorization will be required if 1980 needs are to be met.

RECOMMENDED AUTHORIZATION
FOR CARRYING OUT THE UPLAND PROGRAM
GENESEE RIVER BASIN

It is recommended that the Secretary of Agriculture be authorized to carry out the upstream aspects of the Genesee River Basin Comprehensive Plan which need to be installed to meet needs identified for 1980 and which are listed in Table J45, with such modifications, thereof, as in the discretion of the Secretary of Agriculture may be advisable.

In carrying out this program, it is recommended that the Secretary of Agriculture be authorized to participate in single and multi-purpose developments for flood prevention, irrigation, drainage, water quality control, fish and wildlife developments, recreation, municipal water supply and accelerated land treatment associated with project plans. Federal technical and cost-sharing assistance should be the same as that contained in other existing authorities provided the Secretary.

The Secretary's participation should be based on project plans to be submitted to him by appropriate agencies of the Department of Agriculture. Such plans will be developed only after appropriate applications have been received by the Secretary from qualified local sponsoring organizations and will be consistent with the findings and provisions of this comprehensive plan. The planning and development work will be coordinated with other federal and state agencies. Operation and maintenance of all developments will be the responsibility of local sponsoring organizations.

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GENESEE RIVER BASIN
COMPREHENSIVE STUDY OF
WATER AND RELATED LAND RESOURCES
APPENDIX J
AGRICULTURAL STUDIES

INTRODUCTION

AUTHORITY

Participation by the United States Department of Agriculture in this survey of the water and related land resources of the Genesee River Basin is under the authority contained in Section 6 of the Public Law 566 as amended. The work was carried out by the United States Department of Agriculture in accordance with the Memorandum of Understanding dated February 2, 1956, between the Soil Conservation Service, Forest Service and Economic Research Service.

The Department of the Army, Corps of Engineers, authorized by a resolution of the Senate Committee on Public Works, served as Chairman of the Genesee River Basin Coordinating Committee ". . . to coordinate fully with the State of New York and the Commonwealth of Pennsylvania, and other federal agencies concerned to insure full consideration of all views and requirements of all interrelated programs, which those agencies may develop with respect to flood prevention, water supply, stream pollution abatement, recreation, fish and wildlife management, irrigation, soil conservation, hydroelectric power, and related water and land resources." The United States Department of Agriculture cooperated with the Corps of Engineers toward the above objectives.

SCOPE AND OBJECTIVES OF STUDY

The United States Department of Agriculture assisted in the preparation of a comprehensive and coordinated plan for the Genesee River Basin. The plan will be available to federal, state and local agencies in their planning and construction activities for the conservation, development and utilization of the water and related land resources to meet the rapidly expanding demands. It is of further interest to the Department that full recognition be given to the irrigation water needs of the Ontario Lake Plain Service Area.1/

1/ Composed of the drainage areas into Lake Ontario between the cities of Lockport and Rochester.

In accordance with the above and in cooperation with local, state and other federal agencies, the Department's objectives were to formulate and evaluate upstream watershed plans in order to:

a. Recommend a plan for land treatment and structural works for installation within the next 10 to 15 year period for the purpose of meeting present and immediately foreseeable needs.

b. Recommend land treatment and structural programs which may meet future water and related land resource needs beyond the 10-15 year period.

To accomplish the above objective, the Department conducted investigations and analyses dealing with (1) an inventory of present water and related land resources, (2) the determination of the overall needs for the water and related land resources, (3) an evaluation of the Basin's capabilities and potential for meeting the needs and requirements and (4) the formulation of a plan and alternatives for meeting the resource needs and requirements both now and in the future.

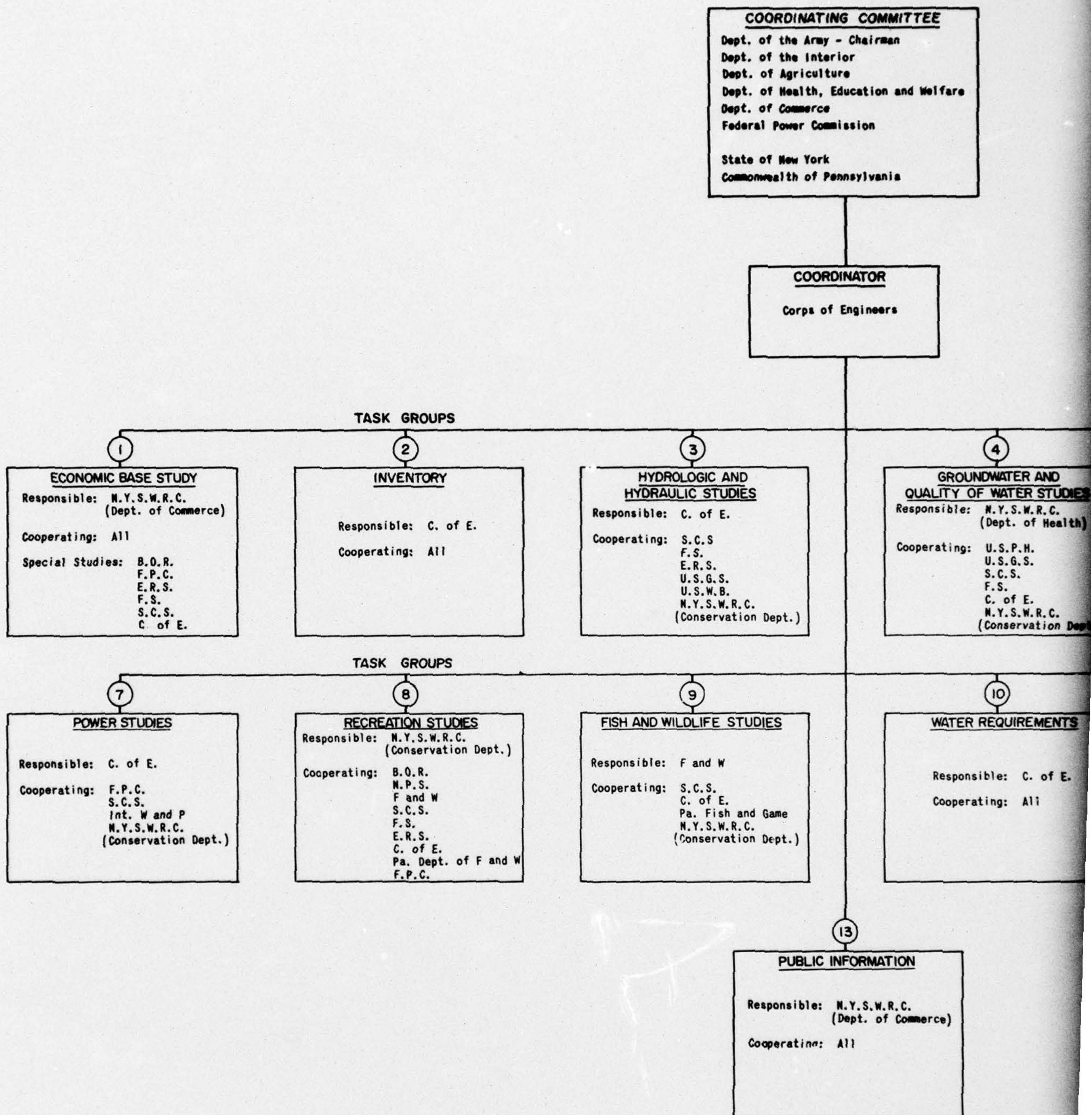
INTER-AGENCY COORDINATION

To effect coordination among the various participating agencies, a Genesee River Basin Coordinating Committee was formed as an initial step in the study. Chaired by the District Engineer, Army Engineer District, Buffalo, Corps of Engineers, membership consisted of one member each from the Departments of Agriculture, Commerce, Health, Education and Welfare, and Interior; the Federal Power Commission; and, the State of New York and the Commonwealth of Pennsylvania.

The State Conservationist of New York State, Soil Conservation Service, represented the U.S. Department of Agriculture on the Genesee River Basin Coordinating Committee. The U.S. Department of Agriculture Field Advisory Committee was established to coordinate departmental activity and consisted of a member from the Economic Research Service, Forest Service and Soil Conservation Service.

The overall study was sub-divided into 13 tasks and technical studies with one agency designated for responsibility for each task, assisted by specified "cooperating agencies." The Department of Agriculture's participation in each of the 13 task groups is as shown on the accompanying organizational chart. (Plate J1.)

GENESEE RIVER BASIN COMPREHENSIVE
ORGANIZATION CHART



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RIVER BASIN COMPREHENSIVE STUDY
ORGANIZATION CHART

COORDINATING COMMITTEE

Dept. of the Army - Chairman
Dept. of the Interior
Dept. of Agriculture
Dept. of Health, Education and Welfare
Dept. of Commerce
Federal Power Commission

State of New York
Commonwealth of Pennsylvania

COORDINATOR

Corps of Engineers

TASK GROUPS

3 HYDROLOGIC AND
YDRAULIC STUDIES
nsible: C. of E.
rating: S.C.S
F.S.
E.R.S.
U.S.G.S.
U.S.W.B.
N.Y.S.W.R.C.
(Conservation Dept.)

4 GROUNDWATER AND QUALITY OF WATER STUDIES
Responsible: N.Y.S.W.R.C. (Dept. of Health)
Cooperating: U.S.P.H.
U.S.G.S.
S.C.S.
F.S.
C. of E.
N.Y.S.W.R.C.
(Conservation Dept.)

5 AGRICULTURAL STUDIES
Responsible: S.C.S.
Cooperating: E.R.S.
F.S.
N.Y.S.W.R.C.
(Conservation Dept.)

6 SEDIMENTATION
Responsible: U.S.G.S.
Cooperating: S.C.S
F.S.
C. of E.
U.S.P.H.
N.Y.S.W.R.C.
(Conservation Dept.)

TASK GROUPS

9 AND WILDLIFE STUDIES
nsible: F and W
rating: S.C.S.
C. of E.
Pa. Fish and Game
N.Y.S.W.R.C.
(Conservation Dept.)

10 WATER REQUIREMENTS
Responsible: C. of E.
Cooperating: All

11 PRELIMINARY AND FINAL SITE SCREENING
Responsible: C. of E.
Cooperating: All

12 PROJECT FORMULATION AND BASIN PLAN FORMULATION
Responsible: C. of E.
Cooperating: All

13 PUBLIC INFORMATION
Responsible: N.Y.S.W.R.C. (Dept. of Commerce)
Cooperatinn: All

AGENCY LEGEND

C. of E.	Dept. of the Army	- Corps of Engineers
B.O.R.	Dept. of the Interior	- Bureau of Outdoor Recreation
F and W		- Fish and Wildlife Service
N.P.S.		- National Park Service
U.S.G.S.		- Geological Survey
Int. W and P		- Interior Assistant Secretary for Water and Power
S.C.S.	Dept. of Agriculture	- Soil Conservation Service
F.S.		- Forest Service
E.R.S.		- Economic Research Service
U.S.P.H.	Dept. of Health, Education and Welfare	- Public Health Service
U.S.W.B.	Dept. of Commerce	- Weather Bureau
F.P.C.	Federal Power Commission	
N.Y.S.W.R.C.	New York State	- Water Resources Commission
Pa. Dept. of F and W	Pennsylvania	- Department of Forests and Waters
Pa. Fish and Game		- Fish and Game Commission

DELINEATION OF STUDY AREAS

Economic Subareas

Economic area and subareas were determined by the Economics Task Group #1. (See Plate J2.) Criteria used were wholesale and retail trade areas, land use, physiographic factors and worker commuting patterns. Four subareas were delineated as follows: Monroe County is a Standard Metropolitan Statistical Area and is considered as one subarea. The Barge Canal area includes Orleans and Wayne Counties because of type of farming activities. Monroe County could be included except for the predominance of industry. Livingston, Genesee, Ontario and Wyoming Counties constitute the Central Plain subarea because of similarity in land resource and farming activities.

Cattaraugus, Allegany and Steuben Counties in New York and Potter County in Pennsylvania lie in the Allegheny highlands and are grouped together as the Allegheny Plateau subarea because of similarities in type of farming, land use, and commuting from Allegany and Potter Counties to employment centers in neighboring Cattaraugus and Steuben Counties.

Land Resource Areas

The land resource areas were studied as delineated in the "Atlas of River Basins of the United States" published by the Soil Conservation Service in June 1963. These areas, two in number for the Genesee River Basin, encompass similar broad patterns of soils, climate, native vegetation, water resources, topography, and land use. The two Land Resource Areas in the Basin are LRA-140, Glaciated Allegheny Plateau and Catskill Mountains in the southern or upper watershed portion of the Basin, hereinafter referred to as Allegheny Plateau and LRA-101, Ontario-Mohawk Plain in the northern or lower watershed portion, hereinafter referred to as the Ontario Plain. The areas are shown in Plate J3.

Watersheds

To effect an orderly system by which the various water and related land resource needs could be studied, the 2479 square mile drainage area of the Genesee River Basin was divided into twenty watersheds. This division (1) defined the Department's responsibilities in the upstream watersheds, (2) permitted a coordinated approach between the Basin's problems and analysis of such by natural hydrologic areas and (3) provided a basis for study and formulation of a plan and alternatives to meet the Basin's needs.

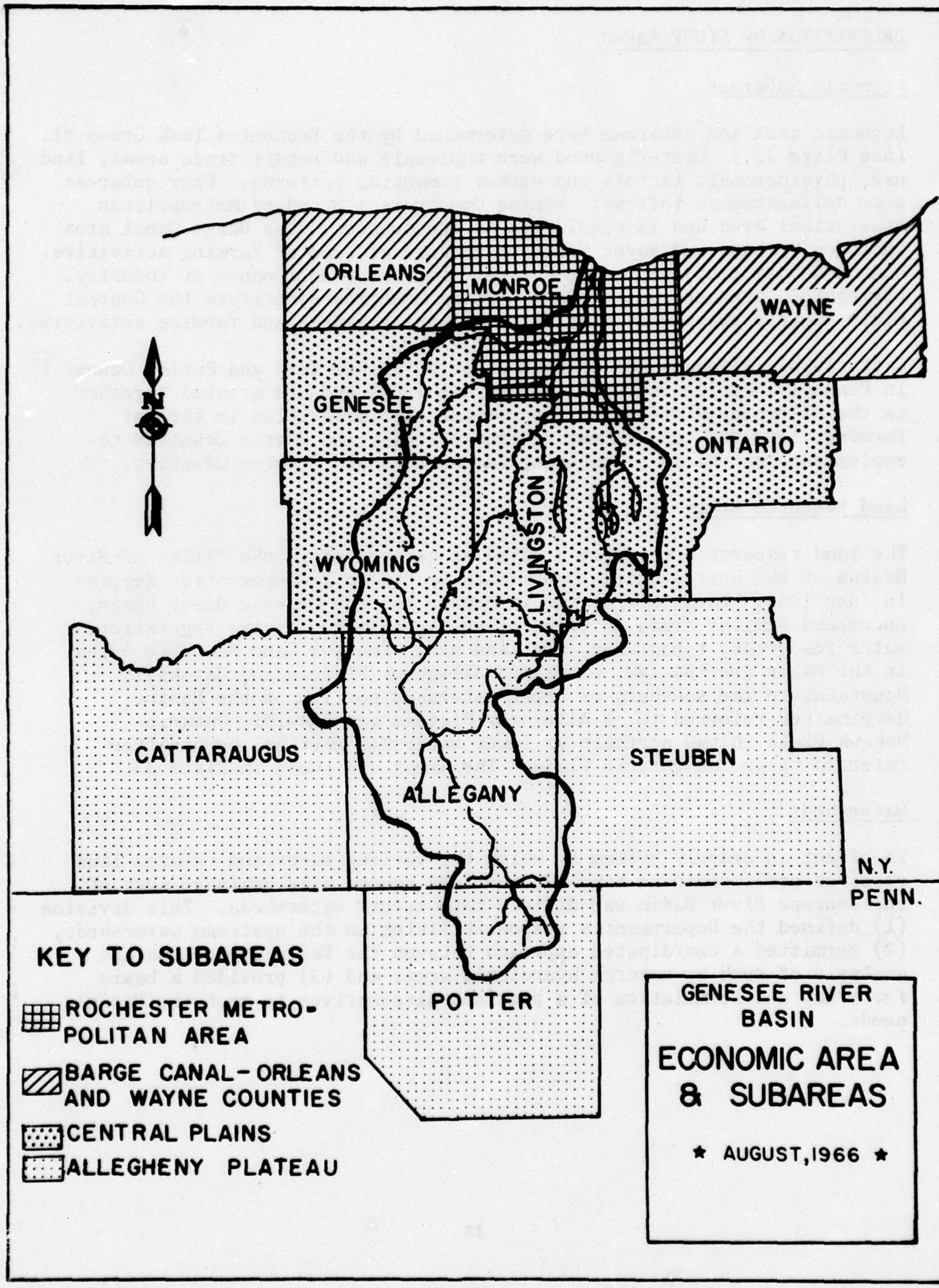
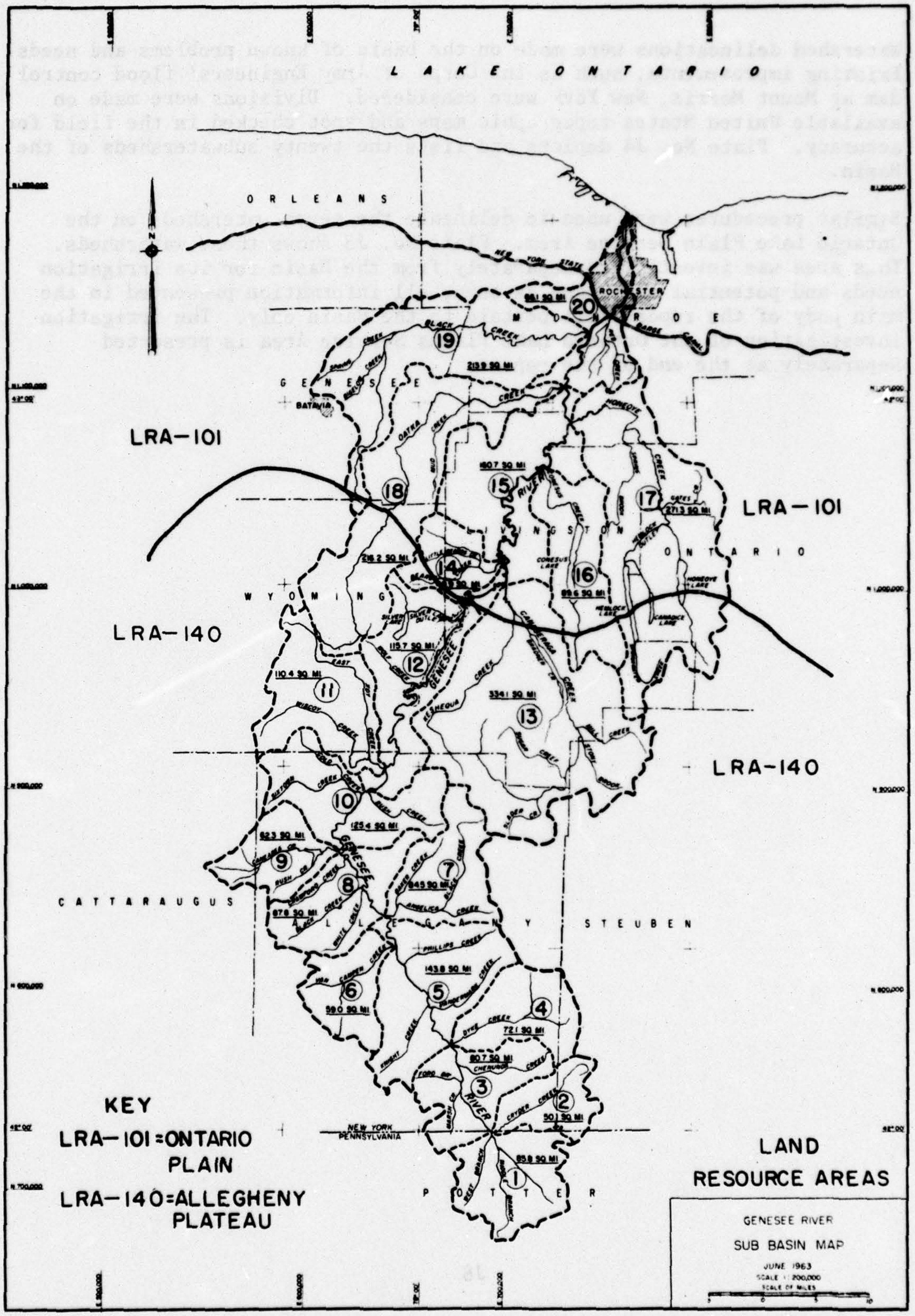

ORLEANS
MONROE
WAYNE
GENESEE
ONTARIO
WYOMING
LIVINGSTON
CATTARAUGUS
STEUBEN
ALLEGANY
N.Y.
PENN.
POTTER
KEY TO SUBAREAS
ROCHESTER METRO-POLITAN AREA
BARGE CANAL-ORLEANS AND WAYNE COUNTIES
CENTRAL PLAINS
ALLEGHENY PLATEAU
GENESEE RIVER BASIN
ECONOMIC AREA & SUBAREAS
★ AUGUST, 1966 ★

Plate J2

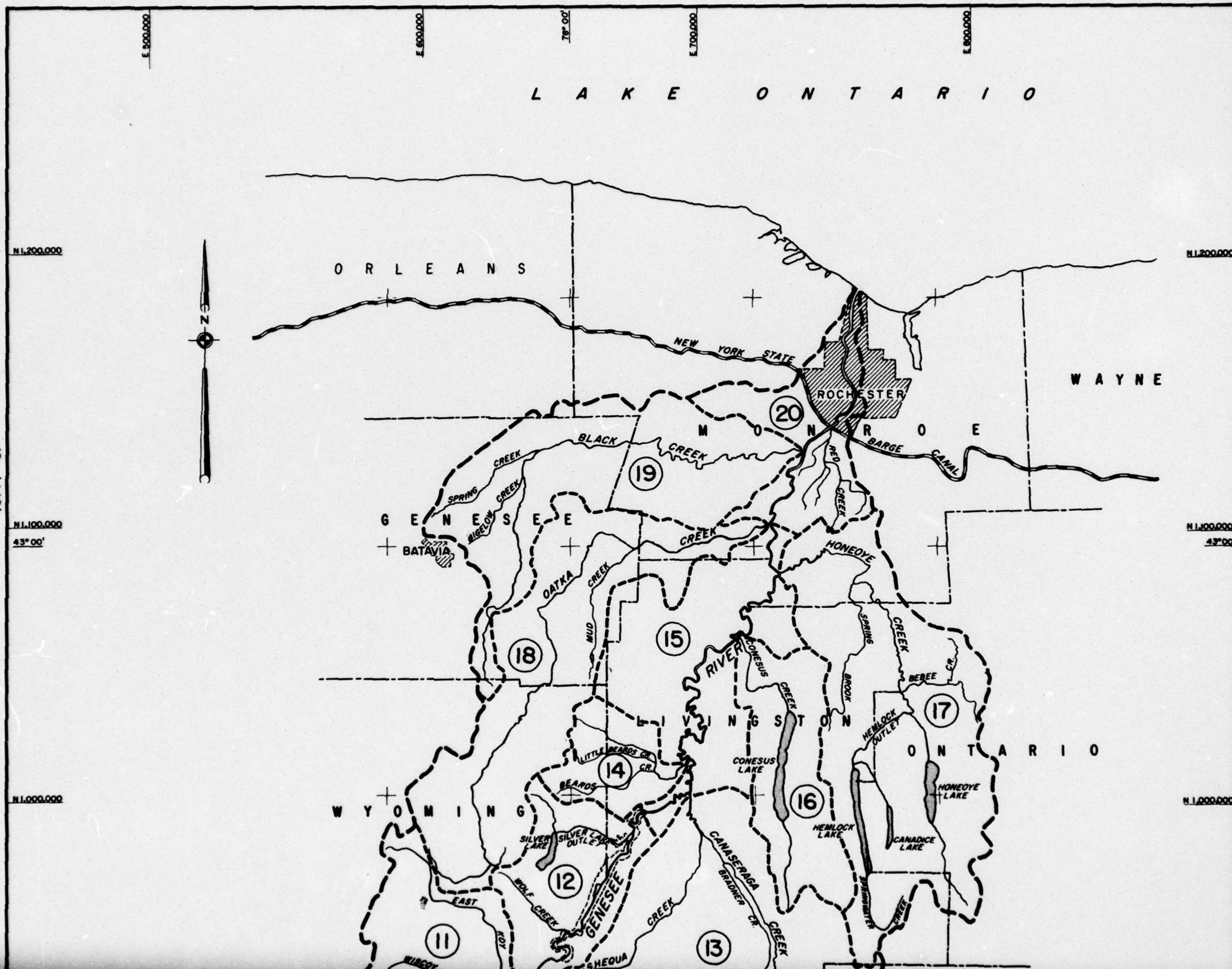


LAKE ONTARIO
ORLEANS
MONROE
ROCHESTER
GENESEE
BATAVIA
LIVINGSTON
ONTARIO
WYOMING
CATTARAUGUS
ALLEGANY
STEUBEN
POTTER
NEW YORK
PENNSYLVANIA
LRA-101
LRA-140
KEY
LRA-101=ONTARIO PLAIN
LRA-140=ALLEGHENY PLATEAU
LAND RESOURCE AREAS
GENESEE RIVER
SUB BASIN MAP
JUNE 1963

Plate J3

Watershed delineations were made on the basis of known problems and needs. Existing improvements, such as the Corps of Army Engineers' flood control dam at Mount Morris, New York were considered. Divisions were made on available United States topographic maps and spot checked in the field for accuracy. Plate No. J4 depicts and lists the twenty subwatersheds of the Basin.

Similar procedures were used to delineate the seven watersheds on the Ontario Lake Plain Service Area. Plate No. J5 shows these watersheds. This area was investigated separately from the Basin for its irrigation needs and potential only, and as such, all information presented in the main body of the report will pertain to the Basin only. The irrigation investigation of the Ontario Lake Plains Service Area is presented separately at the end of the report.


E 500,000
E 600,000
78° 00'
E 700,000
E 800,000
N 1,200,000
N 1,100,000
43° 00'
N 1,000,000
LAKE ONTARIO
ORLEANS
WAYNE
MONROE
GENESEE
LIVINGSTON
ONTARIO
WYOMING
ROCHESTER
BATAVIA
NEW YORK STATE
BARGE CANAL
BLACK CREEK
SPRING CREEK
BIGELOW CREEK
OATKA CREEK
MUD CREEK
RED CREEK
HONEOYE CREEK
SPRING BROOK
BEBEE CR.
HEMLOCK OUTLET
CONESUS CREEK
RIVER
CONESUS LAKE
HEMLOCK LAKE
CANADICE LAKE
HONEOYE LAKE
SPRINGWATER
LITTLE BEARDS CR.
BEARDS CR.
SILVER LAKE
SILVER LAKE OUTLET
WOLF CREEK
GENESEE
CANASERAGA CREEK
BRADNER CR.
KESHEQUA CREEK
EAST KOY
WISCOY
N
11
12
13
14
15
16
17
18
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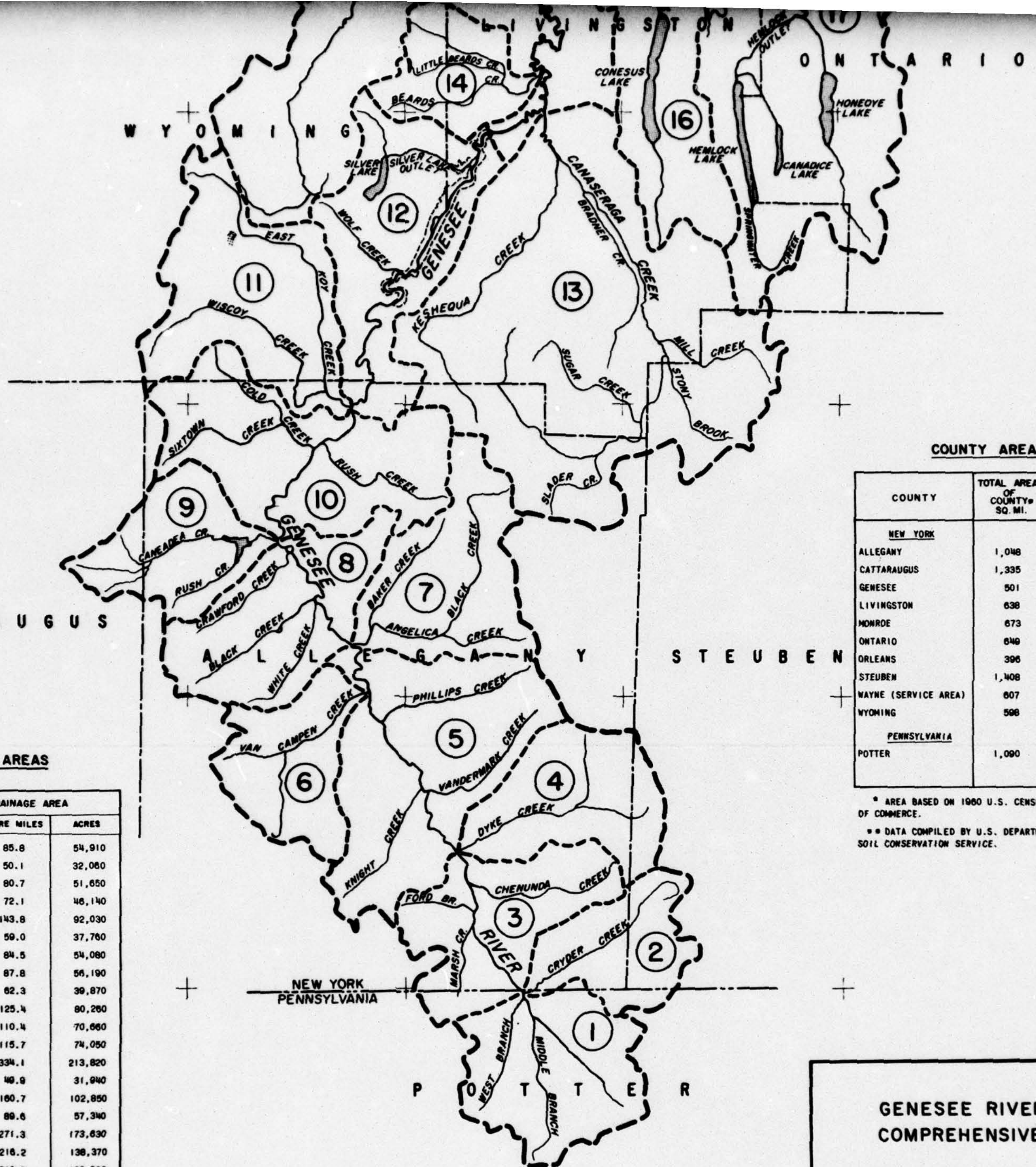
J9 (J10)



SUBWATERSHED AREAS

SUBWATERSHED		DRAINAGE AREA	
NUMBER	NAME	SQUARE MILES	ACRES
1	GENESEE - SOUTH	85.8	54,910
2	CRYDER CREEK	50.1	32,060
3	GENESEE - CHENUNDA	80.7	51,650
4	DYKE CREEK	72.1	46,140
5	GENESEE - VANDERMARK	143.8	92,030
6	VAN CAMPEN CREEK	59.0	37,760
7	ANGELICA CREEK	84.5	54,080
8	GENESEE - SOUTH BLACK	87.8	56,190
9	CANEADEA CREEK	62.3	39,870
10	GENESEE - COLD CREEK	125.4	80,260
11	WISCOY CREEK	110.4	70,660
12	SILVER LAKE OUTLET	115.7	74,050
13	CANASERAGA CREEK	334.1	213,820
14	BEARDS CREEK	49.9	31,940
15	GENESEE - GENESEO	160.7	102,850
16	CONESUS LAKE	89.6	57,340
17	HONEOYE CREEK	271.3	173,630
18	OATKA CREEK	216.2	138,370
19	BLACK CREEK	213.9	136,900
20	GENESEE - ROCHESTER	66.1	42,300
TOTAL		2,479.4	1,586,810

DATA COMPILED BY U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE.

COUNTY AREAS

COUNTY	TOTAL AREA OF COUNTY* SQ. MI.	AREA WITHIN GENESEE RIVER BASIN** SQ. MI.
NEW YORK		
ALLEGANY	1,048	769.8
CATTARAUGUS	1,335	14.0
GENESEE	501	202.6
LIVINGSTON	638	619.4
MONROE	673	248.8
ONTARIO	649	136.8
ORLEANS	396	4.0
STEUBEN	1,408	86.7
WAYNE (SERVICE AREA)	607	0
WYOMING	598	301.7
PENNSYLVANIA		
POTTER	1,090	95.6
		2,479.4

* AREA BASED ON 1960 U.S. CENSUS, U.S. DEPARTMENT OF COMMERCE.

** DATA COMPILED BY U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE.

GENESEE RIVER BASIN
COMPREHENSIVE STUDY

COUNTY AND SUBWATERSHED AREAS

PLATE J4

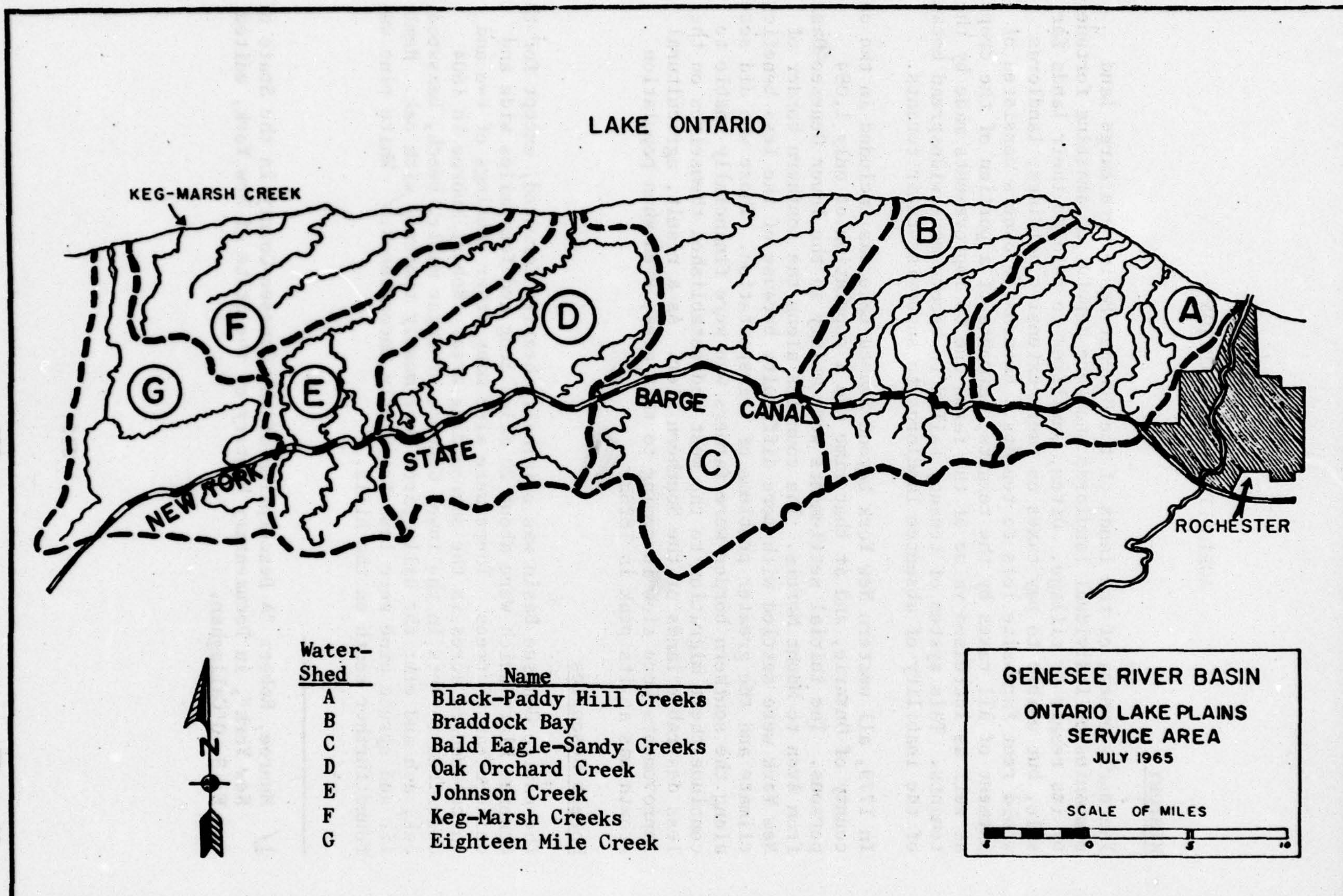

LAKE ONTARIO
KEG-MARSH CREEK
A
B
C
D
E
F
G
BARGE CANAL
NEW YORK STATE
ROCHESTER
N
Water-Shed
Name
A Black-Paddy Hill Creeks
B Braddock Bay
C Bald Eagle-Sandy Creeks
D Oak Orchard Creek
E Johnson Creek
F Keg-Marsh Creeks
G Eighteen Mile Creek
GENESEE RIVER BASIN
ONTARIO LAKE PLAINS
SERVICE AREA
JULY 1965
SCALE OF MILES

Plate J5

AGRICULTURAL DESCRIPTION

HISTORY

The early owners of the lands of the Genesee Basin were large land companies or individual landlords who were hopeful of amassing fortunes by its resale or tillage. Often, unwilling to release their lands for sale, but unable to pay taxes on their extensive holdings, landlords would rent farm-size lots to tenants. Returns to owners consisted of payment of all taxes by the tenants, payments of a portion of the crops, as well as increased value of the farms due to improvements made by the tenants. This system of tenancy failed to become more widespread because of the inability of absentee landlords to supervise their tenants.

In 1779, all western New York beyond Seneca Lake was included in the one county of Ontario, and at that time had a population of only 1,084 persons. The initial settlements were mainly in the lower Genesee Basin from Avon to Mount Morris. The counties along the southern border of New York were settled with more difficulty because of the less beneficial climate and the greater problems of transportation. Those who did settle along the southern border were farmers who were financially unable to continue their migration to the west and established themselves on the less desirable lands of the Southern Tier. As a result, agricultural improvements were slow in coming to this area, even when population growth was at its peak in 1825.

Forest Resources

The entire Genesee Basin was originally heavily forested, except for the Genesee Flats which were about 20 miles long and four miles wide and quite clear of trees. There were also many other openings of two and three hundred acres in the surrounding area. Robert Munroe in 1804 described forests in the lower Genesee of sugar maple, beech, basswood, oak, ash and elm; the hilly parts were mostly timbered with oak. Hemlock, fir and spruce pine were less frequently encountered.[1/] White pine was found further south on the hills.

1/ Munroe, Robert "A Description of the Genesee County in the State of New York", in Documentary History of the State of New York, edited E. B. O"Callaghan.

The timber was cut and burned to clear the land and in many settlements the first money was secured from the sale of ashes for the potash salts derived from them or from the sale of charcoal. Grist and sawmills sprang up wherever a little water power could be developed. In 1789 a grist and sawmill was built on the present site of Rochester.1/ By 1790 sawmills had been constructed at the site of present Avon and in East Bloomfield, Ontario County.2/

In 1818 the Genesee was declared a "public highway" for the floating of logs to the mills.2/ As soon as there was a market and a means of transportation, lumbering became the leading industry. The Genesee Valley Canal, begun in 1837, from Rochester to Olean via Portage, Oramel and Belfast, was completed in 1856. One of the reasons for its construction was to make abundant supplies of pine lumber from the Plateau available to the lower Basin. McNall states: "The benefits of the canal are difficult to weigh, but certainly it contributed to stripping the hills of their forest cover . . ."3/

The Erie Railroad had been built into Allegany County in 1851, giving a further impetus to lumbering operations. Between 1835 and 1860 the number of sawmills decreased from 186 to 95, but the value of the product increased from $114,000 to $354,000. Asheries, producing pot and pearl ash, receded in importance as improved transportation permitted marketing wood in less concentrated forms. Tanneries followed lumbering, using the hemlock which the loggers frequently left as valueless.4/ By the 1870's the forests had been badly depleted and lumbering was on the decline.5/

Soil differences were given little attention by the early settler who had little to guide him in the selection of land on which to settle. When soil became too poor for profitable cultivation (generally after 10 to 12 years) it was abandoned and a new field of "virgin" soil was wrested from the forest. The abandoned fields were later grazed or else reverted to trees.6/

1/ First Annual Report of the Conservation Commission, 1911. Report of the Conservation Commission on the Watershed of the Genesee.
2/ Fox, William R., A History of the Lumber Industry in the State of New York, USDA Bureau of Forestry, Bulletin No. 34, 1902.
3/ McNall, Neil Adams, An Agricultural History of the Genesee Valley 1790-1860, University of Pennsylvania Press, 1952.
4/ Ibid., "A Description of the Genesee County in the State of New York".
5/ Clune, Henry W. The Genesee 1963.
6/ The Resources of the Allegheny Plateau, State University College of Forestry at Syracuse University, November 1962.

In 1885, New York State created a Forest Commission, primarily concerned at that time with reforestation and forest fire protection. The law which created it also provided for awakening an interest in forestry in the public schools and colleges, and for providing free information on the care of forests on private lands and on the reforestation of lands denuded by cutting or fire. (Additional responsibilities in the conservation field were added starting in 1895 and the Commission gradually evolved to the Conservation Department in 1931). The Genesee Valley Association was organized in 1891 to arouse public sentiment in Western New York in forest preservation and reforestation.1/ New York State established a College of Forestry in 1898 and the first professional foresters were employed by the Forest, Fish and Game Commission in 1900.

The Third Annual Report of the New York State Water Supply Commission in 1908 states that "There appears to be a remarkably small amount [of forest cover on the Genesee above Portage]; so far as examined the drainage is nearly deforested." In that same year the State offered to furnish young trees at cost as an inducement to reforest. Meanwhile, in 1902, Rochester had made the earliest plantings in the State on a municipal watershed, that surrounding Hemlock Lake.

At present the Central Lowlands' portion of the basin is 18 percent forested and the Appalachian Plateau portion is 29 percent forested.

In writing of the entire Allegheny Plateau area in New York State, a study group of the State University College of Forestry wrote in November 1962:

> "While most of the land in the region has been farmed or grazed at some time during the past century, much that is not actively tended is now reverting to tree growth, almost entirely hardwood growth. At present, nearly 40 percent of the entire region is woodland, and it appears probable that some two-thirds of the total area may well be supporting forest growth by the end of another decade or two." (See Photo J1)

> "Because of poor soils, rough topography, and the consequent poor competitive position of hill lands versus the better valley soils, hill lands are likely to remain in forests in the future."2/

1/ Whipple, Gurth Fifty Years of Conservation in New York State 1885-1935, Conservation Department and New York State College of Forestry, 1935.

2/ Op. cit. The Resources of the Allegheny Plateau

In 1930, the first Forest Districts were established, and beginning in 1931, New York State began to purchase a considerable amount of abandoned sub-marginal farmland for reforestation purposes. By March 1964, 106,820 acres in the five Appalachian Plateau counties in the Basin were in State ownership as reforestation and multiple-use areas other than parks.1/ From 1909 to 1962 over 189,000,000 coniferous tree seedlings were planted in these five counties, roughly enough to reforest 190,000 acres. (See Photo J2)

Agriculture

Pre-canal agriculture was characterized by an unsuccessful search for a cash product which could be easily shipped. Failure to develop such a product resulted in a severe shortage of money, and occasionally led to the use of barter among Genesee settlers.

In most cases, settlers from New England were able to adapt their methods of agriculture to conditions in the Genesee Valley. Livestock raising, once widely advocated for the Valley, did not gain great prominence because of the cost in money and time for establishing herds of cattle or sheep and the enthusiasm for wheat growing.

The opening of the Erie Canal in 1825 vastly reduced the cost of shipping a bushel of wheat to New York and, therefore, increased the price to the farmer proportionately. This led to a great expansion in the growing of wheat, mainly for export. Wheat was chosen because of the ready market, the relative ease of cultivation (compared with livestock raising), and the low initial investment required.

The impetus of wheat growing alleviated, for the most part, the shortage of cash among the Genesee farmers who were now assured a competitive place in the eastern market. Rochester became a great flour and barrel manufacturing center. Genesee Valley wheat was the standard in the market for a short time.

Compared to the Midwest, the relative disadvantage in the character of soil and topography resulted in a decline of wheat production in the Basin. This was greatly accentuated by the coincidental development of farm machinery especially adapted to broad level acres and by the rapid transportation facilities afforded by the railroad. With the decline of wheat production, a gradual increase in livestock production took place and reached a peak during the Civil War. After 1875, land values shrank rapidly and only the best farms could be maintained in active tillage.

1/ New York State Conservation Department

In each decade in the last third of the nineteenth century, the cultivated area in New York was less than in the preceding one. Livestock, especially sheep, hogs, and beef cattle were reduced in numbers together with the reduction in acreage of tilled crops.1/

The type of agriculture found today with dominance of dairy farming has developed since 1920. Rural farm population and numbers of farms have continually declined with consequent declines in cropland harvested. On the other hand, rural nonfarm population has increased so that the total rural population for most areas has remained relatively constant. The recent growth in urban population in the vicinity of Rochester has withdrawn much good cropland from production.

Adjustments in the acreage of various crops grown and type of livestock raised have continued to change in response to production changes in other parts of the country and to changes in the consumption patterns of a more affluent population. The general crop and livestock farms that prevailed for so long are gradually being replaced by specialized dairy farms where an emphasis is on forage production for cow feed. Much of the concentrate and grain feed is shipped into the Basin. Acreage and production of potatoes have declined largely because of the change in eating habits. Fruit production in the Basin has declined as the old orchards, once found on almost every farm, are left untended or have been uprooted. The area along Lake Ontario has absorbed and concentrated much of the fruit production formerly found scattered throughout the Basin. Vegetable production expanded slowly in the Basin after the vegetable processing industry was introduced in Wayne County in 1866. Additional processing plants were established in Rochester in 1870 and in Fairport in 1880.2/ By 1890, counties in the area grew about 7,000 acres of vegetables. This acreage increased rapidly and reached 70,000 acres by 1930, but growth has been limited since then, the 1959 acreage being 72,000.

Specialization such as has been achieved in milk, vegetable and fruit production after a long period of general farming can be attributed to advances in transportation, electrification and mechanization. Transportation has always been a major factor in agricultural development in the Genesee. As noted, it shifted the wheat belt westward. Beef, pork

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1/ Fippin, Elmer O., "Rural New York, 1921" the McMillan Company, New York
2/ "A History of the Canning and Freezing Industry in New York State," as recorded by the New York State Canners and Freezers Association on the occasion of its 75th anniversary, 1960.

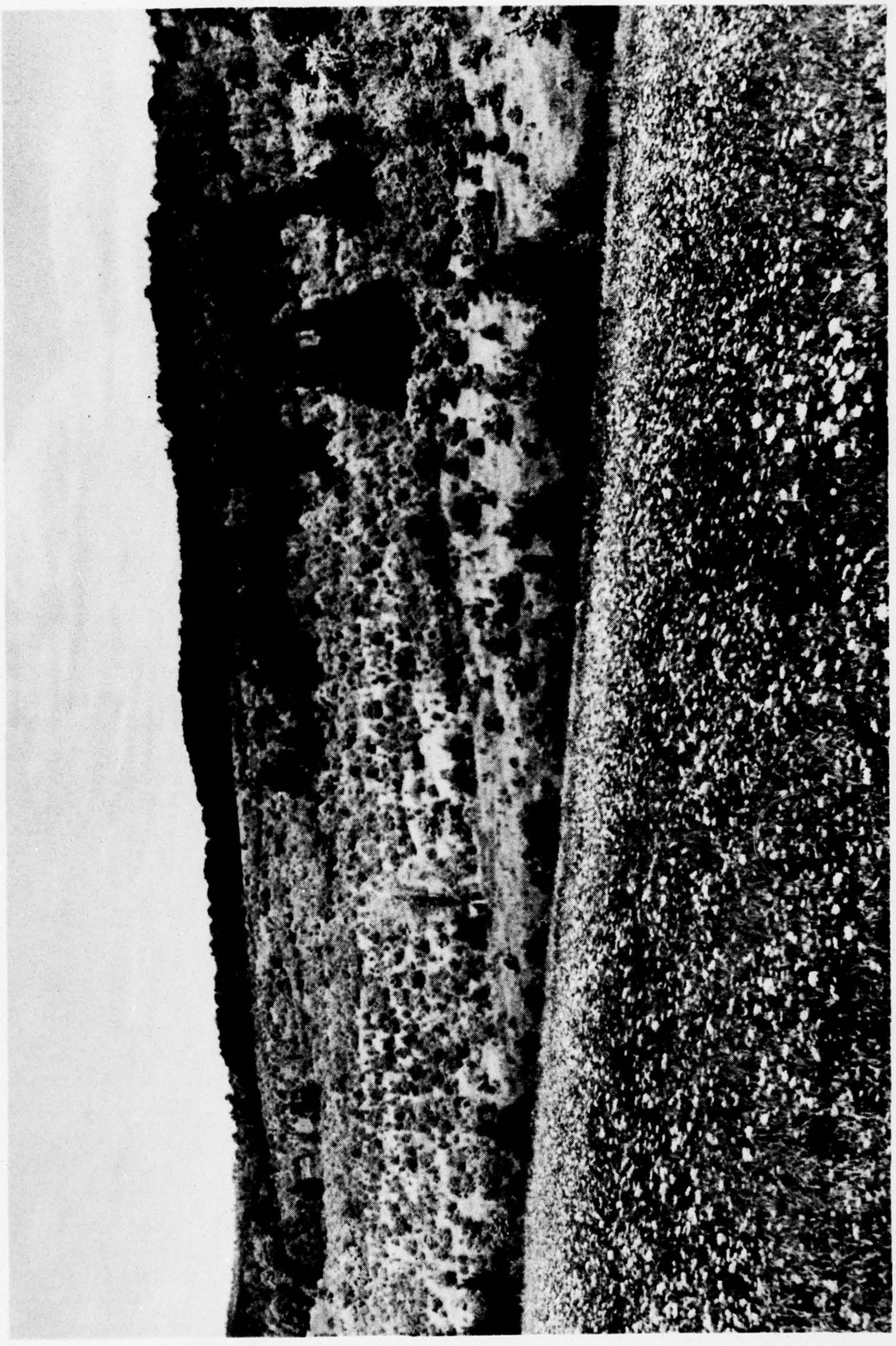


Photo J1. Abandoned agricultural land reverting to forest

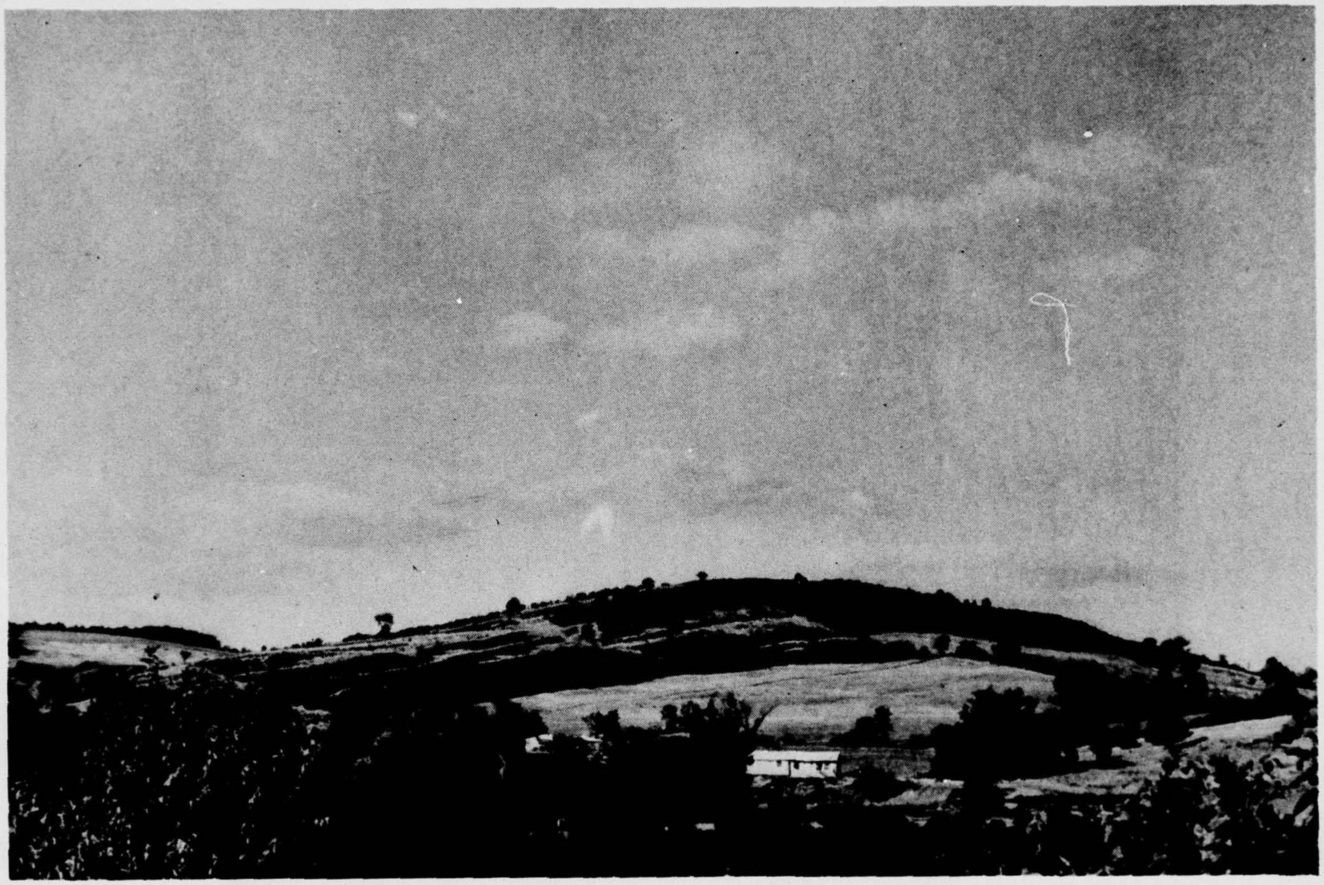


Photo J2. Red pine plantations on a hillside

and lamb and wool reached peak numbers during the Civil War. As the railroads reached out through the area, it became possible to ship milk to nearby markets and butter and cheese to distant markets. In 1890, four times as much milk was made into butter and cheese as was sold for fresh milk. By 1930, the next to last decade that butter was produced on farms as reported in the Census of Agriculture, less than half of the milk produced was made into butter on farms. Rural electrification, improved roads and competition with margarine put butter making nearly out of the picture by about 1940. Milking machines and other labor saving machinery made it possible for one man to take care of an ever-increasing number of cows.

GEOLOGY

The geology of the Basin has been influenced by the continental glaciation which began about one million years ago during the Pleistocene Epoch. This event shaped the topography and redistributed the soils.

Over 400 million years ago, the rocks which are presently found in the Basin began to form. A large inland sea developed over the area and sands, silts and gravels, which were eroded from a mountainous area to the east, were deposited in this sea. In lagoonal areas of this vast body of water, evaporation of sea water took place and salt crystalized from the water and sank to the bottom where it accumulated. Calcium-secreting animal life, such as shellfish and corals built extensive reefs and accumulated as lime rich deposits.

As the sediment accumulated, the earth's crust yielded to the added weight and the sea floor sank making room for additional sediment. Compaction of the material occurred as more and more sediment accumulated as layers of sand, silt and lime mud. Over 8,000 feet of rock were formed over a period of 200-300 million years.

The region was then uplifted and slightly warped during a period of crustal unrest. With the rocks exposed, weathering and erosion of the rock began to take place. Development of drainage patterns, landforms, and deep soils dominated the geologic processes for the next one to two hundred million years. The underlying structures and their influence on surface topography are shown in Plate J6.

Two million years ago the Pleistocene Epoch or the "Ice Age" began and directly influenced the Basin. Continental glaciers formed in the north, expanded and advanced southward. Newly formed soils and weathered rock were scraped away and carried ahead by the massive ice sheet. Some of these soils and rocks became part of the ice mass. When the glacier began to melt, the leading edges receded northward. At times, the glacier's advance equaled the rate of melting and a stable condition existed. Thick

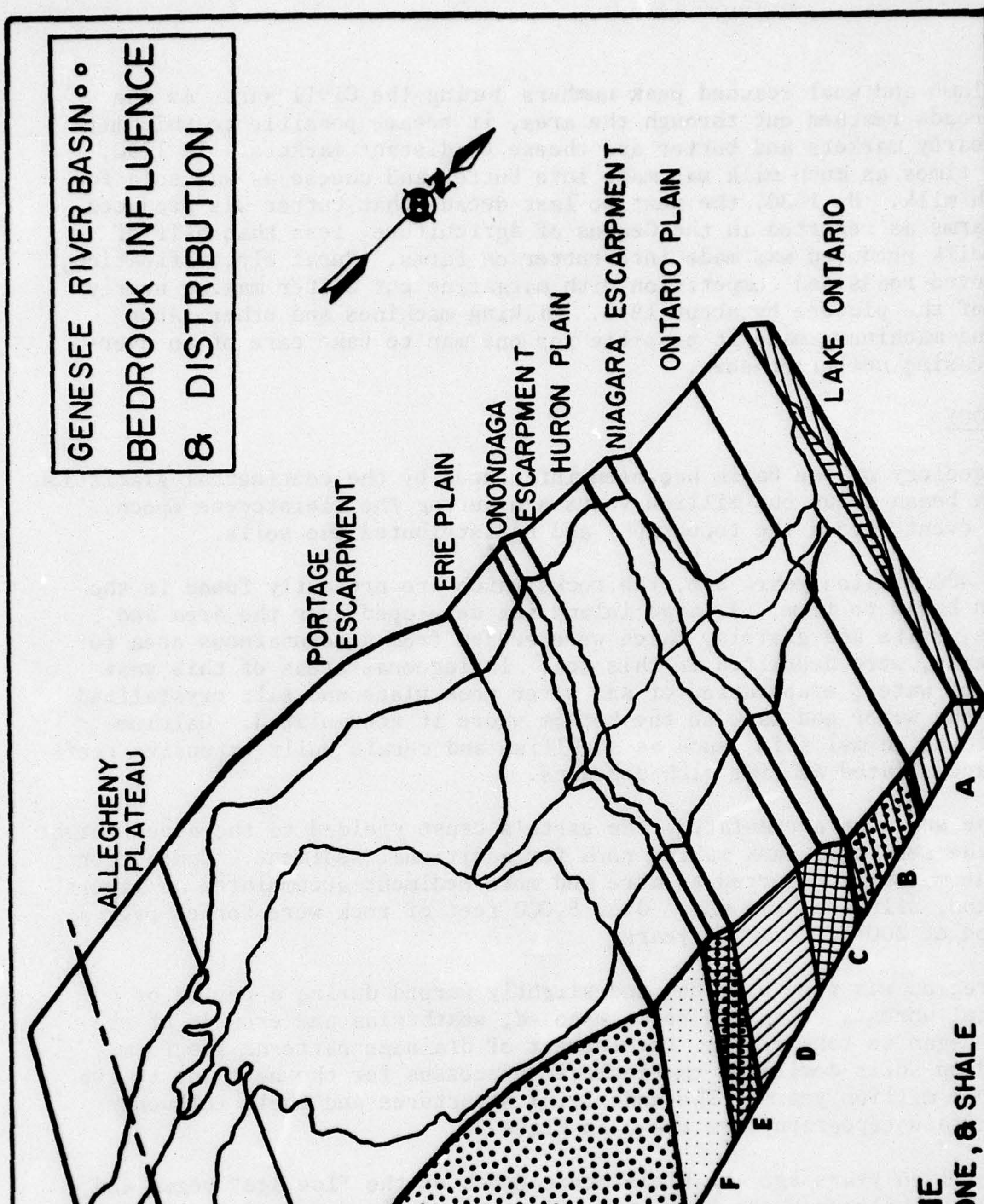

GENESEE RIVER BASIN
BEDROCK INFLUENCE
& DISTRIBUTION
ALLEGHENY PLATEAU
PORTAGE ESCARPMENT
ERIE PLAIN
ONONDAGA ESCARPMENT
HURON PLAIN
NIAGARA ESCARPMENT
ONTARIO PLAIN
LAKE ONTARIO
PENN.
N.Y.
A
B
C
D
E
F
G
H
LEGEND
A = SHALE
B = SANDSTONE & SHALE
C = LIMEROCKS
D = SHALE WITH SALTS
E = LIMEROCKS
F = LIMEY SHALE
G = SHALE & SILTSTONE
H = SILTSTONE, SANDSTONE, & SHALE

Plate J6

accumulations of glacial debris called moraines formed, often blocking the existing drainage channels. Lakes formed, fed by the meltwater. Overflow of these lakes often cut new outlets as was the case in the Genesee River which formed the Letchworth and Rochester gorges.

Normal deposition of the material from the retreating glacier was in the form of glacial till. This was a mixture of the soil and rock scraped up by the glacier regardless of the original characteristics of these materials. As a result the overall soils in the area tend to be stony and somewhat infertile. Some of the fine grained material has migrated through leeching to a zone referred to as the fragipan layer between one and three feet below the surface. These fine particles render this zone somewhat impermeable and results in poor drainage.

In other areas where sand and gravel deposits were formed in the valleys, the subsurface drainage is excessive. Often these zones are good sources of water.

Erosion continued through four advances and retreats of the glaciers and is still going on. Present day topography is influenced by the greater resistance to erosion of certain rock (see Plate J6). Portage, Onondaga, and Niagara escarpments are limestones or siltstones which have resisted erosion in contrast to the shales and softer rocks of the Erie, Huron and Ontario plains. These escarpments show up in many streams as falls.

SOILS

Plate J7 depicts the various soil associations encountered within the Genesee River Basin. The Basin can be divided into two fairly well defined areas in comparison of Soil Associations and their characteristics; namely, southern or Allegheny Plateau Land Resource Area and the Northern Ontario Plains Land Resource Area.

The Allegheny Plateau area has soil associations ranging from the Volusia-Mardin-Lordstown and Lordstown-Volusia-Mardin series to the Chenango-Tioga and Caneadea-Canaseraga series. The general characteristics of several of these associations follow.

The Volusia-Mardin-Lordstown soils of the Allegheny Plateau occupy broad areas on both sides of the Genesee River in upland sections. This is a region of marginal agriculture on what are generally thought of as poor soils. These soils are strongly acid, have a low natural fertility which require many limings and fertilization for average yields. The dominant type of agriculture is dairying, with much of the land wooded, idle, and pastured.

The Chenango-Tioga association occupies the valley floors of the plateau section and along the streams of this section of the Basin. The association includes some of the best agricultural land of the plateau area. The soils are mostly level, well drained and have excellent physical properties. The soils in this association are strongly acid and require lime.

The Caneadea-Canaseraga association is found in the Genesee Valley from Belmont in Allegany County north to Portageville in Livingston County. These are heavy textured and restricted in drainage. Dairying is the only type of agriculture practiced.

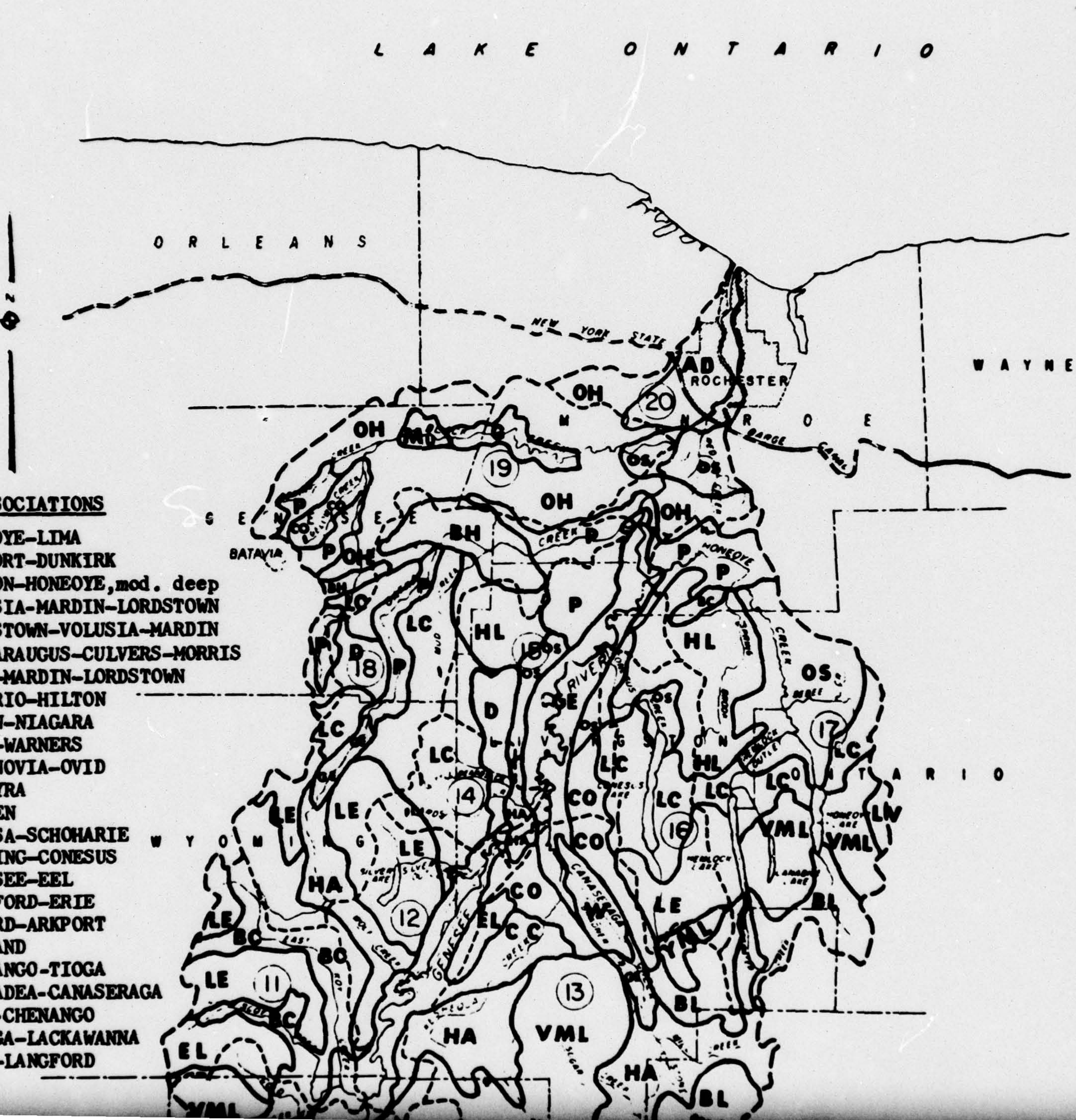
The Ontario Plains Land Resource Area region of the Basin contains considerably more soil associations than does the Allegheny Plateau Area. These soils in general are more fertile, higher in lime and better suited for crop production. The Honeoye-Lima association is typical of these productive soils. This association occupies lands in north central Livingston County, east of the Genesee River and in northwest Livingston County extending into Wyoming County. Some of the most prosperous agriculture of the Basin is in these areas. Dairying in conjunction with general farming and vegetable production are the principal types of agriculture practiced.

The Ontario-Hilton association occupies extensive areas of the Ontario Plain. It covers a large continuous area; just north of the limestone section in northeastern Genesee County and southwest Monroe. It also extends from Genesee County east across the entire width of the Basin. The dominant soils of this association are adapted to a wide range of crops which include corn for grain and silage, small grains, alfalfa and many different varieties of vegetables.

Because soils play such an important part in the use and potential uses of the land resource, the subject is treated in detail in a United States Department of Agriculture attachment to this report. The attachment is entitled "The General Soil Areas of the Genesee River Basin." This publication describes such items as composition, distribution and suitability of use for such needs as agriculture, residential, recreation, topsoil, irrigation, etc.

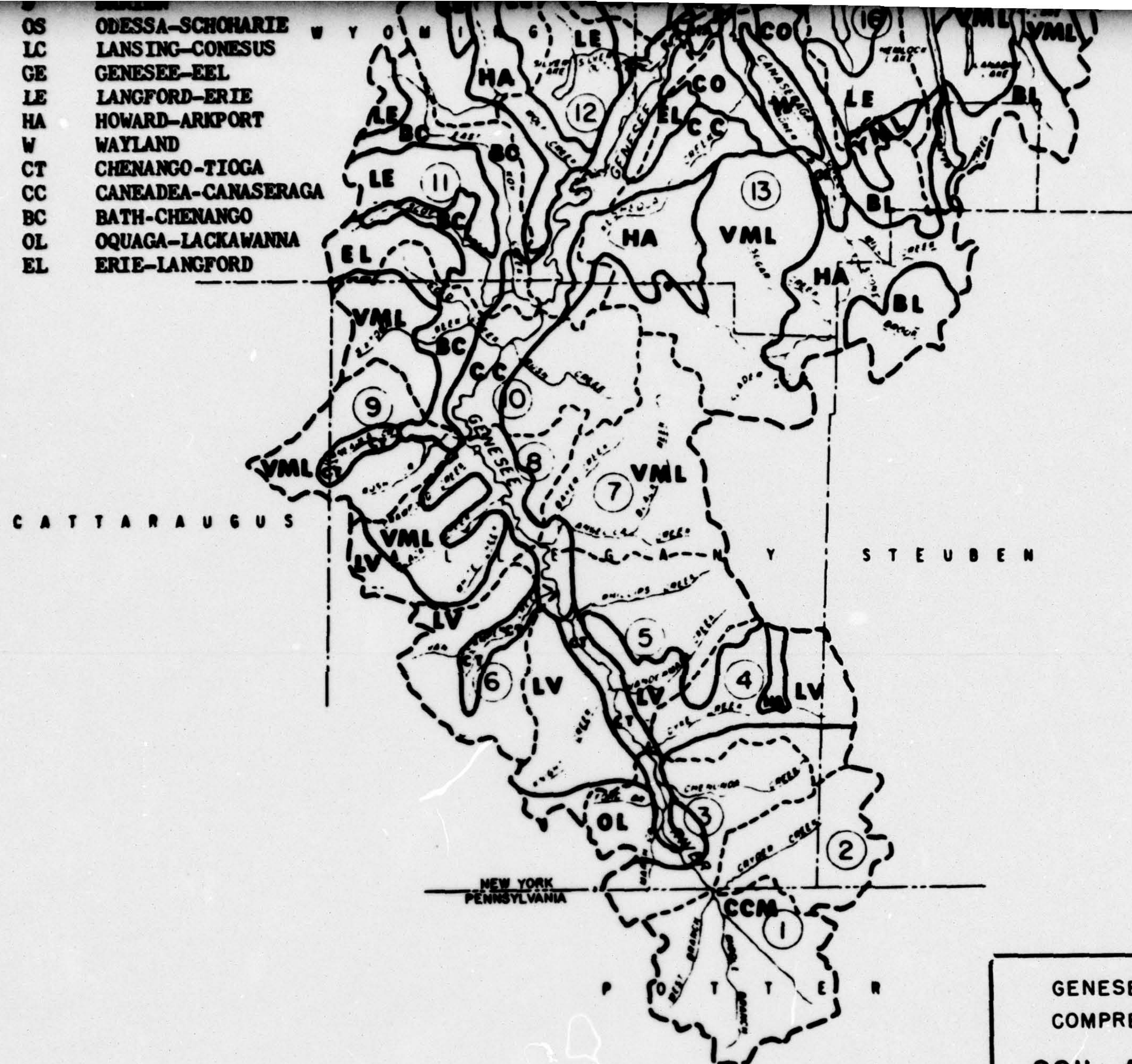
LAND RESOURCE AREAS

The Ontario-Mohawk Plain or Land Resource Area 101, is a nearly level to rolling glacial drift plain. Low beach ridges are a common feature. Local relief is mainly a few feet to a few ten's of feet. Elevations range from about 250 feet to 1,000 feet rising gradually from the lakeshore to the Allegheny Escarpment, which forms the southern boundary of the area.



SOIL ASSOCIATIONS

HL	HONEOYE-LIMA
AD	ARKPORT-DUNKIRK
BH	BENSON-HONEOYE, mod. deep
VML	VOLUSIA-MARDIN-LORDSTOWN
LVM	LORDSTOWN-VOLUSIA-MARDIN
CCM	CATTARAUGUS-CULVERS-MORRIS
BL	BATH-MARDIN-LORDSTOWN
OH	ONTARIO-HILTON
GN	GALEN-NIAGARA
MU	MUCK-WARNERS
CO	CAZENOVIA-OVID
P	PALMYRA
D	DARIEN
OS	ODESSA-SCHOHARIE
LC	LANSING-CONESUS
GE	GENESEE-EEL
LE	LANGFORD-ERIE
HA	HOWARD-ARKPORT
W	WAYLAND
CT	CHENANGO-TIOGA
CC	CANEADEA-CANASERAGA
BC	BATH-CHENANGO
OL	OQUAGA-LACKAWANNA
EL	ERIE-LANGFORD



GENESEE RIVER BASIN
COMPREHENSIVE STUDY

SOIL ASSOCIATIONS

Plate J7

About eighty percent of the land in the Land Resource Area is in farms although only forty percent of the total land or one half the farmland is used for crops. The largest acreage is in feed and forage crops in support of dairying but a wide variety of cash crops including canning and truck crops, various fruits, and winter wheat are also grown. The remaining farmland is divided about equally into permanent pasture and farm woodlots. Of the twenty percent of the total area not in farms, about one-half is in urban uses and the remainder is in miscellaneous uses such as rural residences, parks, etc.[1/]

The Glaciated Allegheny Plateau and Catskill Mountains, or Land Resource Area 140, is a dissected plateau. Broad, nearly level to moderately sloping hill tops, and narrow valleys with steep walls and smooth floors dominate the landscape. Elevations range from about 500 to 1,000 feet on the valley floors, and from about 1,700 to 2,000 feet on the plateau tops. The area is mainly in farms but large acreages are forested. Hay, pasture and some grain in support of dairying are the principal crops grown. Potatoes are locally important on the plateau tops and in some valleys. Forested areas are cut-over mixed hardwoods; abandoned or idle areas are in Poverty grass, annual and perennial weeds, Hawthorne and other shrubs. About one-third of the area is in cropland, one-third is in forest, and the remaining one-third is about equally divided between pasture and other uses. A very small portion, about two percent, is in urban use.

CLIMATE

In addition to describing some of the more pertinent climatological data, this section of the report will attempt to describe how the various climatological and physical factors affect the availability and distribution of surface water within the upstream watersheds of the Genesee River Basin.

Precipitation

The mean annual precipitation in the Ontario-Mohawk Plain Land Resource Area 101 is 34 inches in the northern part of that area and 32 inches in the southern part. The mean annual precipitation in the Glaciated Allegheny Plateau and Catskill Mountains Land Resource Area 140, is 37 inches. Over one-half of this precipitation falls during the growing season. The amount of snow fall in winter, especially along Lake Ontario and east of Lake Erie, is about 80 inches. Mean annual total snowfall ranges from 48 inches to 80 inches in the Allegheny Plateau area.

1/ Conservation Needs Inventory Printouts by Land Resource Areas and Watersheds, 1958.

Two general types of storms produce the precipitation over the Genesee River Basin. Convergent or frontal storms occurring along the line separating air masses of differing characteristics cover large portions of the Basin and are by far the most common. These storms will form during any season of the year and during winter months can produce large amounts of snowfall. Frontal storms of significant intensity and duration to produce flooding over several watersheds occur on the average of once every five years. This type or frequency of storm generally produces three to five inches of rainfall over a 24 to 48 hour period. Convectional or local thunderstorms are the second type of storm that occurs throughout the Basin. These types are less frequent than frontal storms and are rather limited in areal extent. They occur sporadically over small areas and at times have affected small portions of individual watersheds. Thunderstorms of a severe nature have produced serious flood conditions in the upstream areas in the Allegheny Plateau area. One such storm occurred in 1947 on a tributary to Cryder Creek in subwatershed #2. The subsequent runoff produced from this storm caused out-of-bank flows through the village of Whitesville of approximately 2.5 feet. Adjoining watersheds received no precipitation from this storm. Precipitation in the form of snowfall adds considerably to the water resource picture of this Basin during the months of November to March. During this period, the average depth of snowfall varies from approximately one foot to those subwatersheds in the Ontario Plain Land Resource Area to 2 feet in the Allegheny Plateau Land Resource Area. Extremes from 4 to 5 feet have been experienced in the Allegheny Plateau region.

Plate J8 (monthly rainfall distribution) shows the average monthly distribution of rainfall for the two land resource areas. As noted, rainfall is fairly well distributed throughout the year with the months of May, June and July normally having the greatest total monthly amounts.

Drought conditions are prevalent in the Genesee River Basin area particularly along the Ontario Lake Plains. In this connection, climatological records have been kept on the number of consecutive days without rain, or without rain of a specified amount, and the departure of rainfall for a certain period from normal. Thornthwaite[1/] studied the climate of areas from the standpoint of the potential net gain or loss of moisture for plant use as the seasons progress. Much of the Genesee River Basin and Ontario Lake Plains Service Area constitutes one of the driest areas of the State, while at the same time having temperatures equal to or higher than other summertime readings in the State. Thornthwaite's system of computing potential evapotranspiration when used with normal temperature

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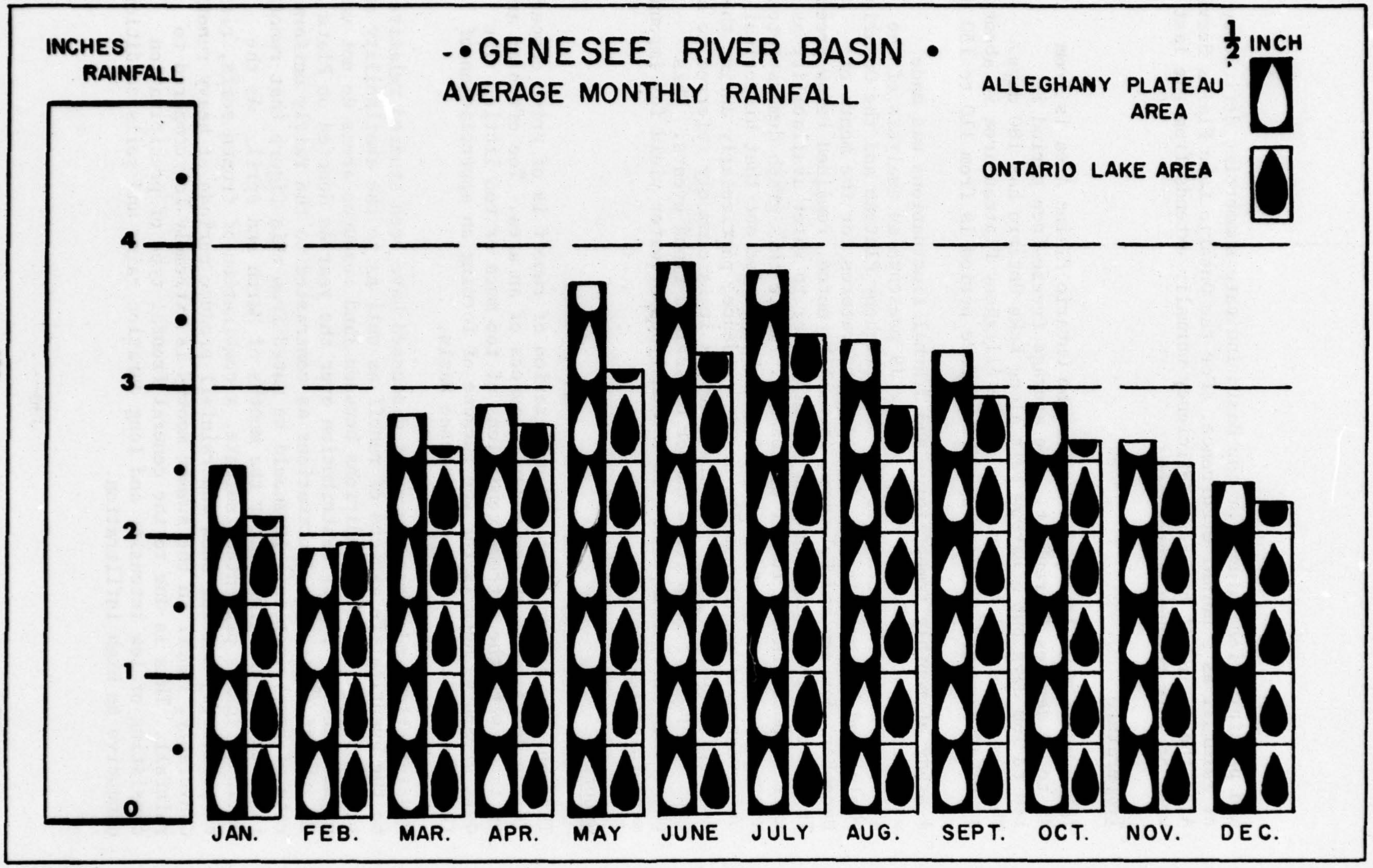
1/ Thornthwaite, C. W. Cohen, Atlas of Climatic Types in the United States, 1900 - 1939, U. S. Department of Agriculture, Miscellaneous Publication #421, 1941.



GENESEE RIVER BASIN
AVERAGE MONTHLY RAINFALL
INCHES RAINFALL
1/2 INCH
ALLEGHANY PLATEAU AREA
ONTARIO LAKE AREA
0
1
2
3
4
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

and precipitation values for the Basin indicate summertime deficiency of rainfall as a normal occurrence. For the Ontario Lake Plains Service Area the period of greatest deficiency normally extends from the last week of July through September.

Temperature

The average annual temperature for the Ontario Plains Area is from 45 to 50 degrees Fahrenheit. The average freeze-free period is 140 to 160 days but a narrow belt along Lake Ontario has 180 days. The average annual temperature in the Allegheny Plateau area is about 47 to 48 degrees. The average freeze-free period is from 110 to 150 days.

A study of monthly temperatures and diurnal fluctuations was made utilizing Weather Bureau data. Plate J9 presents an analysis of the average monthly temperatures for the Allegheny Plateau and the Ontario Plain Land Resource Areas. Average temperatures for the month of December, January and February, it will be noted, remained below freezing. This fact becomes important as a contributor to water availability as will be noted in the runoff discussion. While this graph demonstrates the average or typical conditions, it must be pointed out that historical occurrences of warming spells are in evidence, particularly during the month of January. This "January Thaw" as it is commonly referred to has been the prime reason for a number of serious flood events. This phenomenon is also important in the analyses of water yield for impoundment investigations.

Runoff

The control, conservation and utilization of runoff is of prime concern in the development of the water resources of an area. Too often an area is faced with the extreme conditions of too much or too little. The data presented here is for the purpose of forming an appreciation of runoff conditions within the Genesee Basin.

Precipitation and temperatures as discussed have been studied relative to the quantitative aspects of runoff as well as to the availability and time aspects. Runoff conditions between land resource areas do not vary significantly. Runoff distribution over the year as denoted on Plate J10 is subject to extreme fluctuations as contrasted to the fairly uniform rate of precipitation. It should be noted from this figure that runoff is in excess of rainfall for the months of March and April. As the various figures presented indicate, a combination of frozen soils, rising temperatures, melting snow and rainfall produce periods of heavy runoff. Conversely, runoff in the summer months is extremely low compared to rainfall. This is due to the general frontal type of precipitation consisting of low intensity and long duration rains and soils conditions conducive to high infiltration.

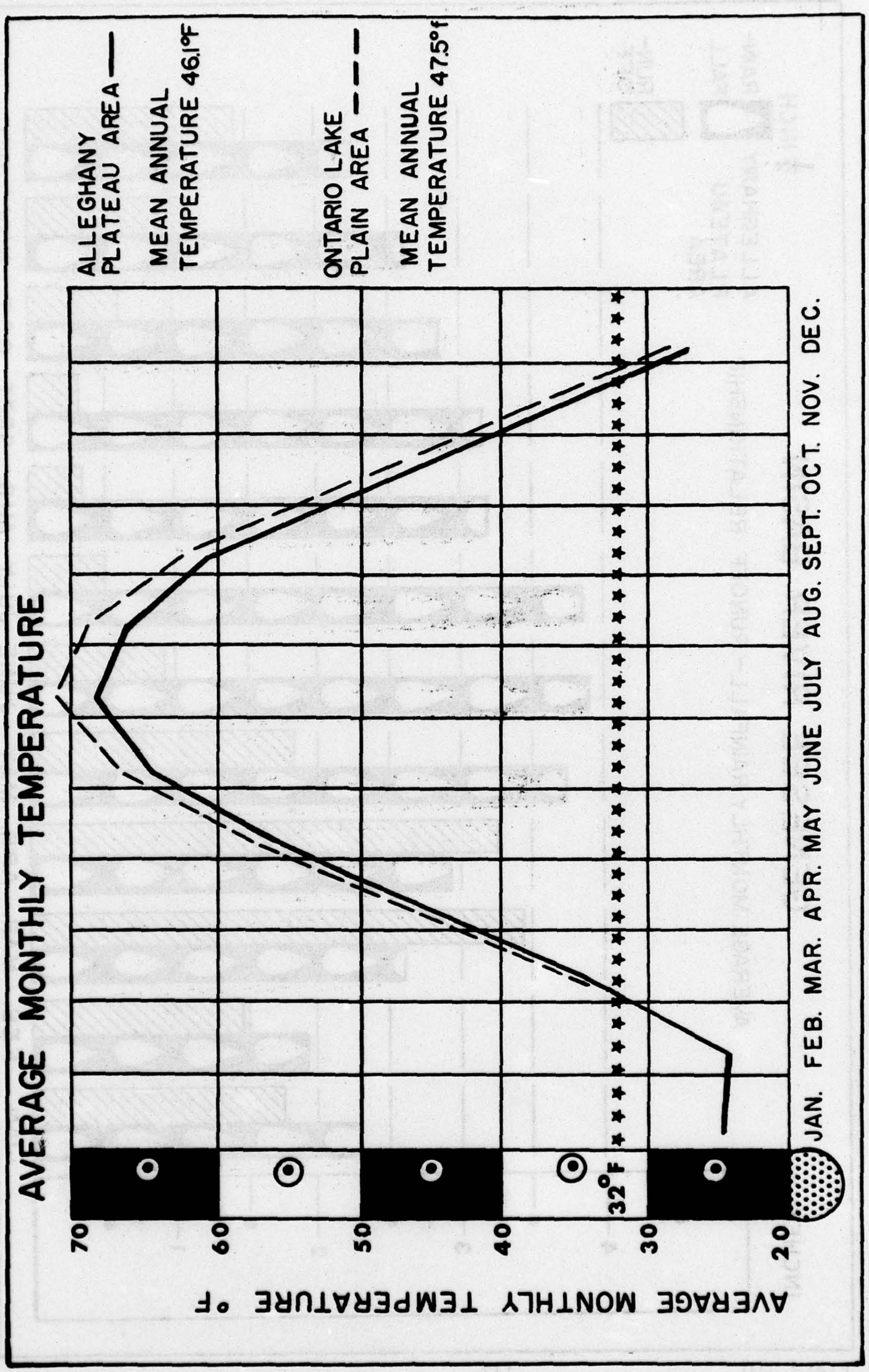
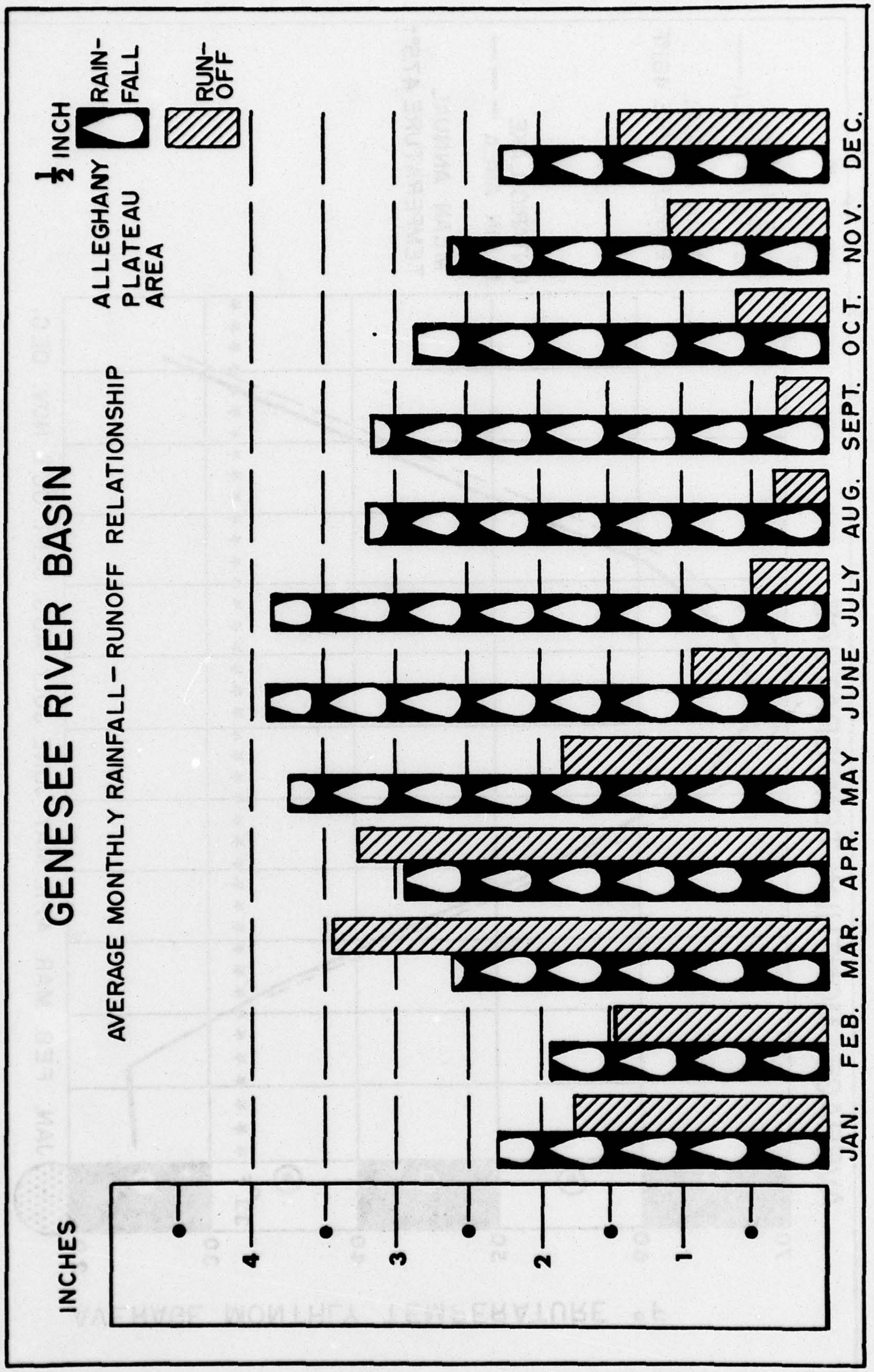

AVERAGE MONTHLY TEMPERATURE
ALLEGHANY PLATEAU AREA
MEAN ANNUAL TEMPERATURE 46.1°F
ONTARIO LAKE PLAIN AREA
MEAN ANNUAL TEMPERATURE 47.5°f
AVERAGE MONTHLY TEMPERATURE °F
70
60
50
40
32°F
30
20
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

Plate J9


GENESEE RIVER BASIN
AVERAGE MONTHLY RAINFALL-RUNOFF RELATIONSHIP
ALLEGHANY PLATEAU AREA
½ INCH
RAIN-FALL
RUN-OFF
INCHES
4
3
2
1
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

Smoothing out of the inherent peaks and troughs in the existing runoff relationships in the upstream watersheds is important to the full development of the Basin's water resources.

THE FOREST RESOURCE

For the purposes of this section, the economic subareas described on Page J5 were modified by combining Monroe County with the Barge Canal area. Throughout this section these whole county units will be used, as opposed to the watershed area of the Genesee River.

Attached to this report are eight tables (J-A1 through J-A8) which give a quantitative description of the forest resource situation in the eleven-county economic area. This section summarizes and highlights these tables.

Forest Area

The area is 35 percent forested. Less than 3 percent of the forest land is unsuitable or unavailable for timber production. Most of this forest is concentrated in the southern portions of the area. Monroe County is only 8.1 percent forested while Potter County is 80.1 percent forested. (See Plate J11)

Urban expansion, industrial development, new highways, increased agricultural productivity, and many other changes in a dynamic economy influence land use. While actual estimates of land-use changes are not available, the Conservation Needs Inventory of New York and the Conservation Needs Inventory of Pennsylvania, which were published in 1958 by the Soil Conservation Service, give a clear indication of future trends in land use within the Genesee River Basin.1/ These reports forecast a 16 percent increase in forest land from 1958 to 1975. All of the eleven counties are expected to increase except one, Orleans, which is expected to decrease by one percent. It should be pointed out that this increase in forest land is common to most rural and semi-rural areas of the East.

1/ USDA - Soil Conservation Service - New York State Soil and Water Conservation Needs Inventory - The New York Conservation Needs Committee - 1962
---Pennsylvania Soil and Water Conservation Needs Inventory - The Pennsylvania Conservation Needs Committee

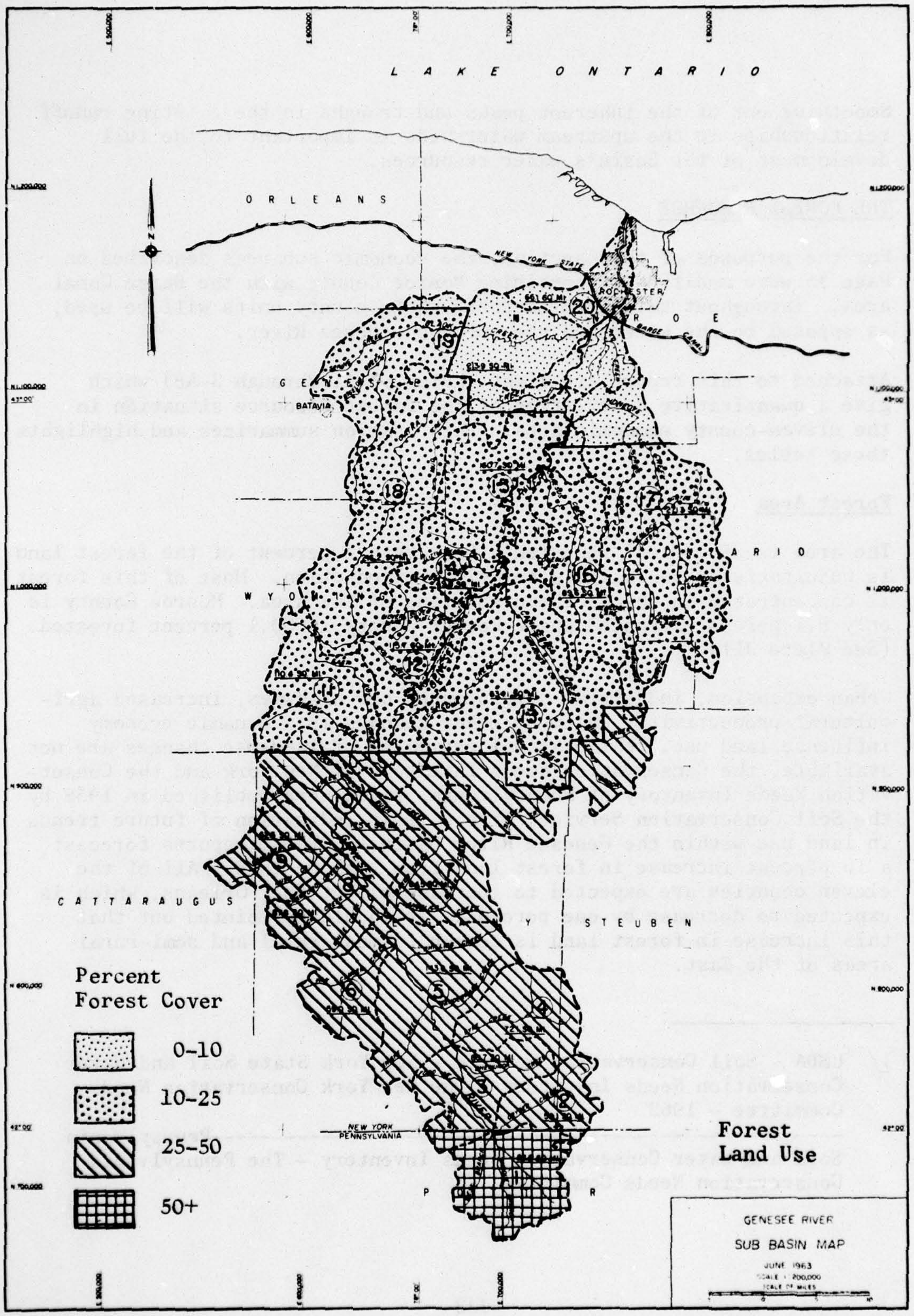

LAKE ONTARIO
ORLEANS
ROCHESTER
BATAVIA
CATTARAUGUS
STEUBEN
NEW YORK
PENNSYLVANIA
Percent
Forest Cover
0-10
10-25
25-50
50+
Forest
Land Use
GENESEE RIVER
SUB BASIN MAP
JUNE 1963

Plate J-11

Forest Ownership

The forest land is primarily held in small private ownerships. Eighty percent of the commercial forest land is privately owned. (See Plate J12) Somewhat less than one-half of private owned commercial forest land is held by farmers while the remainder is held by other private owners. These "other private owners" include professional people, businessmen, housewives, factory workers and retired people as well as forest-based industries.

Of the commercial forest in public ownership, the state holds 96 percent while county and local governments hold the remaining four percent.

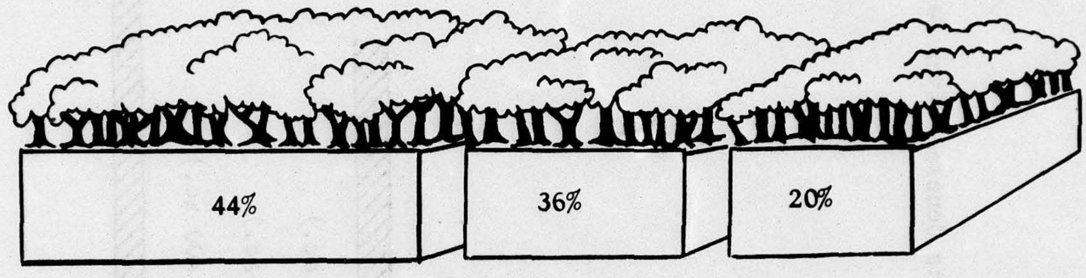


Plate J12. Forest Land Ownership, Genesee River Basin

Forest Types

Ninety-seven percent of the forest land is in hardwood forest types. The most common is the northern hardwood type, which usually contains sugar maple, beech, yellow birch and, particularly in southern sections, black cherry. Oak-hickory is the second most commonly occurring type. White pine-hemlock is the most common softwood type. Plate J13 shows the percent distribution by types.

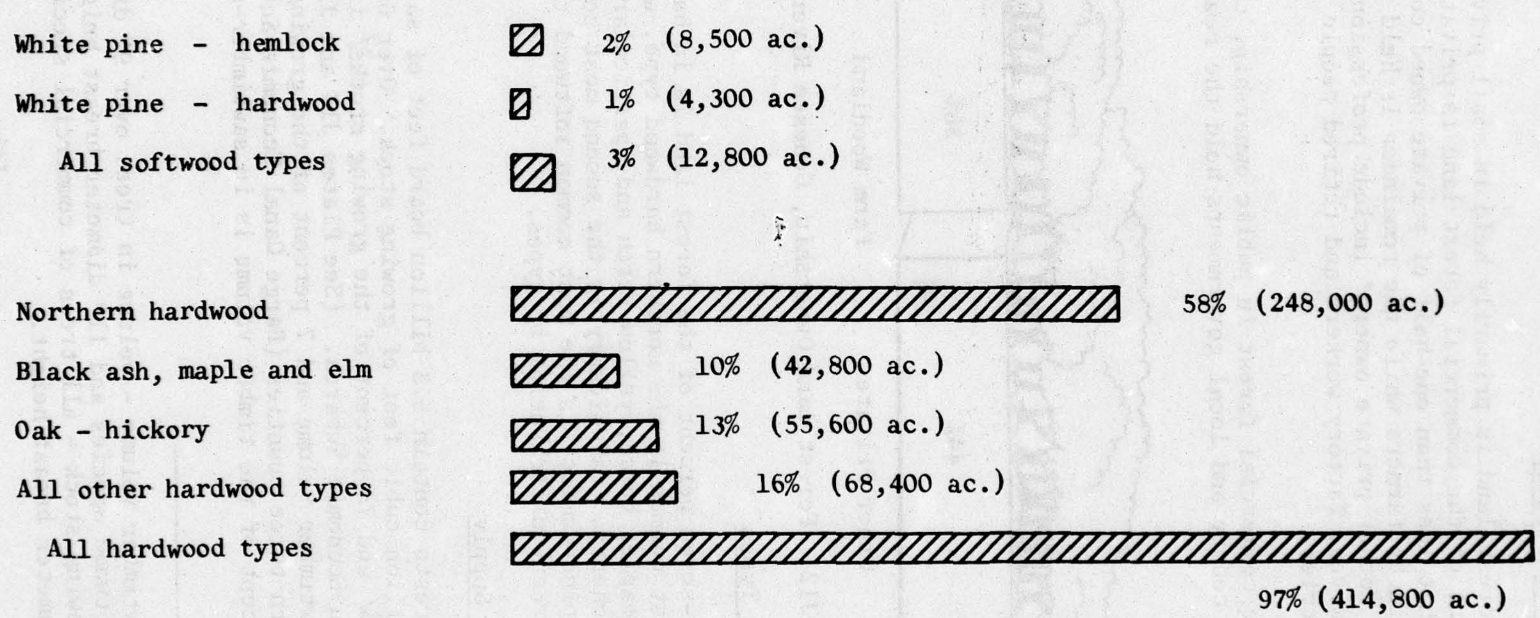
Timber Supply

The forests contain 5.3 billion board feet of sawtimber and a total of 2.7 billion cubic feet of growing stock. Over 65 percent of the sawtimber volume[1/] and 78 percent of the growing stock[2/] is found in the Allegheny Plateau Economic Subarea. (See Plates J14 and J15). Only 10 percent of the sawtimber volume and 7 percent of the growing stock are found in the northern three counties (Barge Canal Economic Subarea). Approximately 40 percent of the timber volume is in sawtimber-size trees.

1/ Sawtimber volume - volume in trees over 9" diameter breast height for softwood species and 11" diameter breast height for hardwood species.

2/ Growing stock - all trees of commercial species 5" and over diameter breast height.

Plate J13. Forest Types in the Genesee River Basin



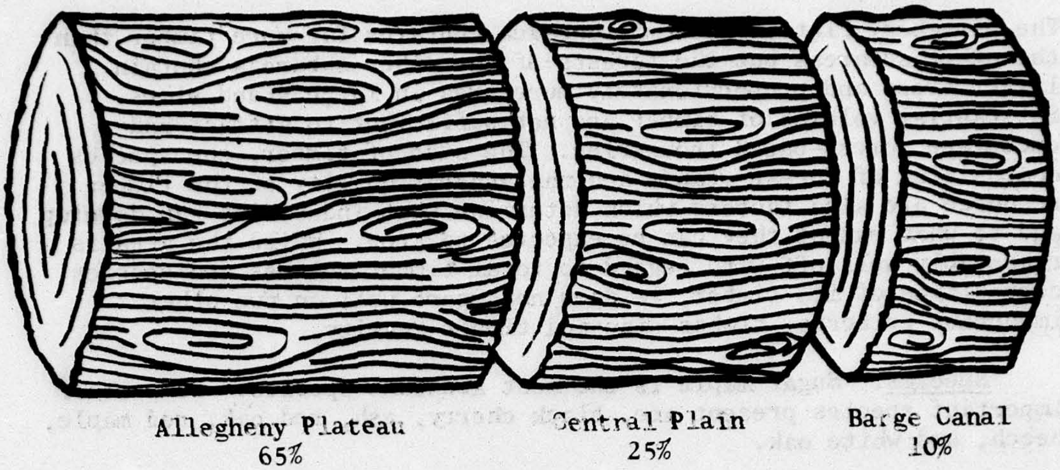


Plate J14. Sawtimber Volume by Economic Subarea, Genesee River Basin

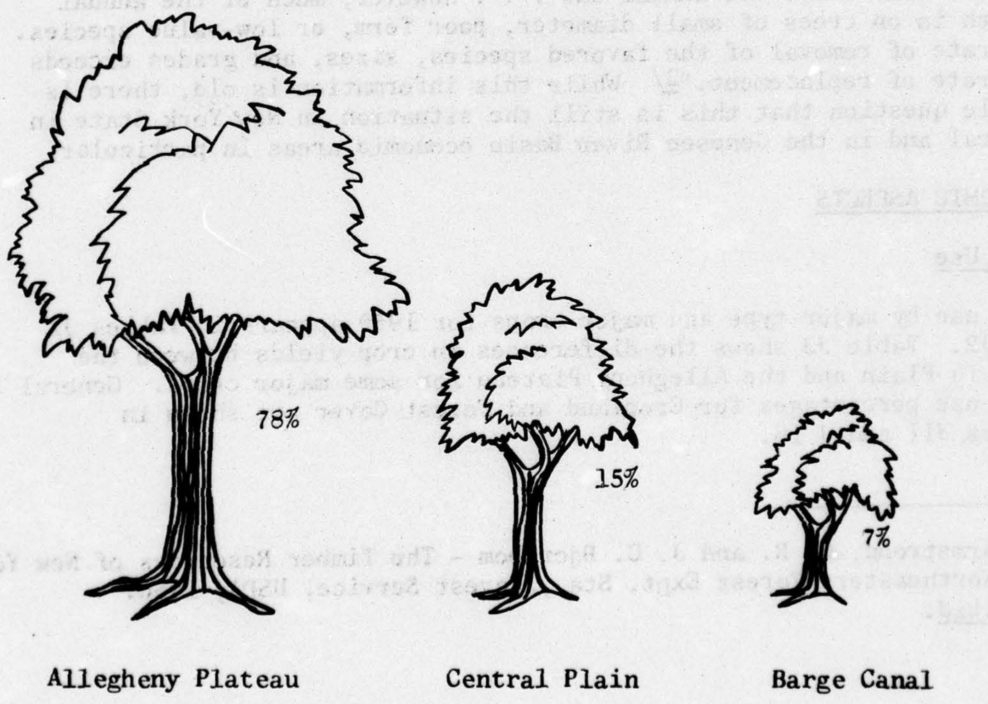


Plate J15. Growing Stock Volume by Economic Subarea, Genesee River Basin.

The Allegheny Plateau Economic Subarea contains far more timber than the other subareas but the forests of the other subareas contain larger trees and proportionately more area in large stand sizes. Substantial volumes of timber are not sufficient to attract and encourage forest-based industries. The size of timber, the species composition of forest stands and the general quality of the timber resource are also factors which determine what industries can develop and to what extent they can be expected to grow. While the area is reasonably well off with regard to total timber volumes and species composition of its timber, it does not score well on two other important criteria, timber size and timber quality.

Species. Sugar maple is the most abundant species. Some other important species present are, black cherry, ash, red oak, red maple, beech, and white oak.

Timber Size. A healthy sawmill industry must have large logs; they require less handling and yield wider, higher quality lumber; thus they are more profitable. Only one-fourth of the softwood sawtimber volume is in trees 16 inches and over in diameter at breast height. For hardwood species the situation is slightly better, approximately one-third is in trees 16 inches and over.1/

Timber Quality. With regard to timber quality, the Forest Survey of New York which was completed in 1954 reports that, "net annual growth is more than twice the annual cut . . . however, much of the annual growth is on trees of small diameter, poor form, or low-value species. The rate of removal of the favored species, sizes, and grades exceeds the rate of replacement."2/ While this information is old, there is little question that this is still the situation in New York State in general and in the Genesee River Basin economic areas in particular.

ECONOMIC ASPECTS

Land Use

Land use by major type and major crops for 1959 appears in Tables J1 and J2. Table J3 shows the differences in crop yields between the Ontario Plain and the Allegheny Plateau for some major crops. General land use percentages for Cropland and Forest Cover are shown in Plates J11 and J 16.

1/ Armstrong, G. R. and J. C. Bjorkbom - The Timber Resources of New York, Northeastern Forest Expt. Sta., Forest Service, USDA, 1956.
2/ Ibid.

Table J1.--Land use for the Genesee River Basin, 1959.

County	Crop	Pasture	Forest	Other	Urban	Water	Total
				--Acres--			
New York							
Allegany	124,640	79,320	185,000	88,930	13,300	1,480	492,670
Cattaraugus	1,610	1,020	5,820	420	90	--	8,960
Genesee	64,830	22,300	21,380	13,740	6,500	910	129,660
Livingston	213,270	69,770	75,180	25,910	7,530	4,760	396,420
Monroe	61,780	10,210	15,800	26,110	44,850	480	159,230
Ontario	26,390	13,820	29,710	10,720	4,290	2,620	87,550
Orleans	600	260	370	1,300	30	--	2,560
Steuben	24,760	7,210	16,530	6,660	220	110	55,490
Wyoming	96,160	26,260	50,300	14,190	5,410	770	193,090
Subtotal	614,040	230,170	400,090	187,980	82,220	11,130	1,525,630
Pennsylvania							
Potter	13,030	9,420	27,500	10,680	370	180	61,180
Total	627,070	239,590	427,590	198,660	82,590	11,310	1,586,810

Source: United States Department of Agriculture, Economic Research Service, and Soil Conservation Service, adapted from the Conservation Needs Inventory and the Forest Survey.

Table J2.--Acreage of major crops, Genesee River Basin, 1959

Crop	Ontario Plain LRA-101	Allegheny Plateau LRA-140	Total Basin
	Acres	Acres	Acres
Corn grain	16,733	8,450	25,183
Corn silage	20,012	15,248	35,260
Hay	72,849	103,469	176,318
Wheat	38,337	15,897	54,234
Oats	32,169	39,898	72,067
Dry beans	20,317	7,078	27,395
Potatoes	4,658	2,240	6,898
Sweet corn	8,903	2,206	11,109
Peas	2,736	587	3,323
Tomatoes	236	9	245
Snap beans	1,681	634	2,315
Total vegetables	15,025	5,870	20,895
Total fruit	3,438	1,105	4,543

Source: Adapted from the Census of Agriculture, 1959

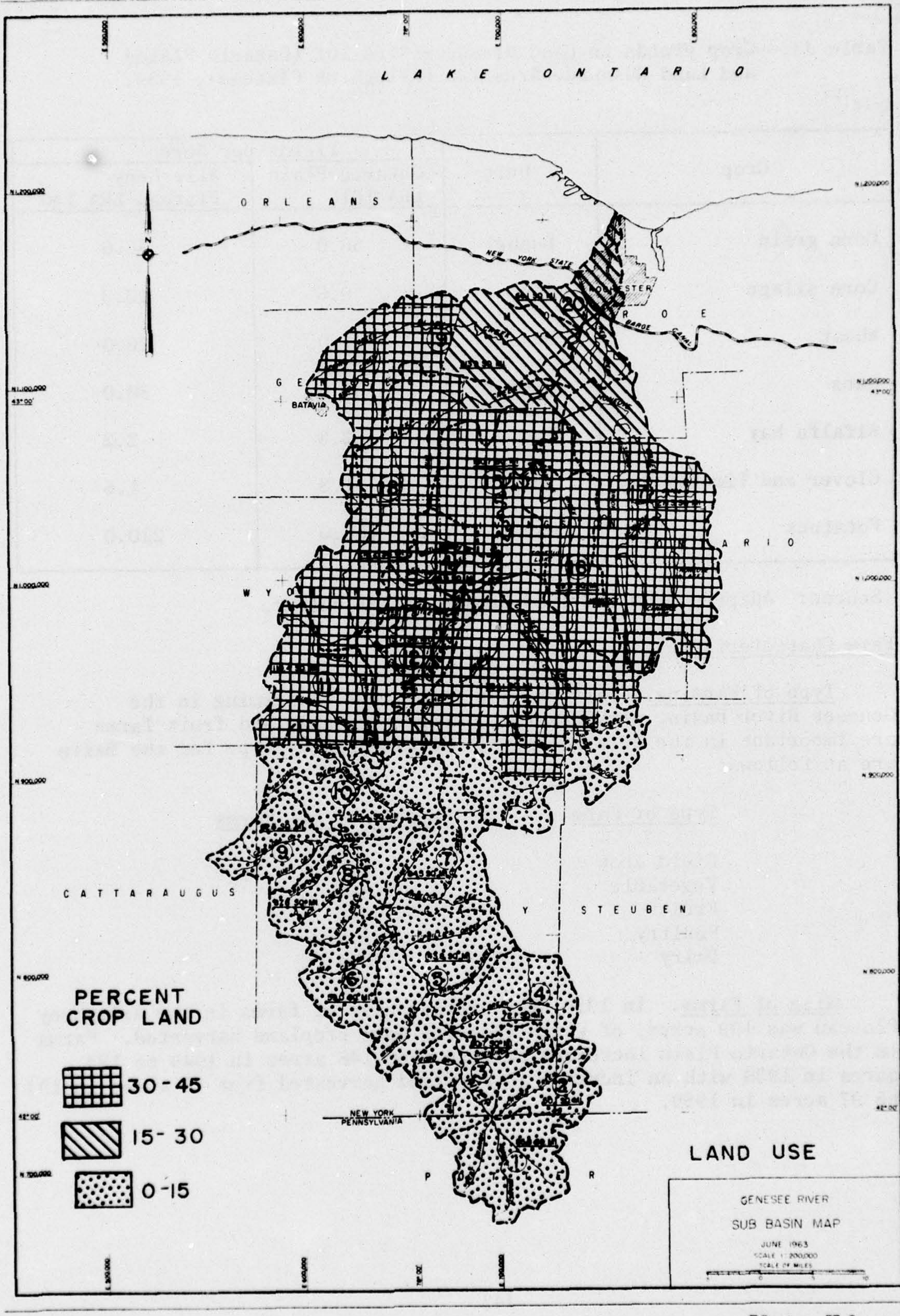

LAKE ONTARIO
ORLEANS
BATAVIA
CATTARAUGUS
STEUBEN
NEW YORK
PENNSYLVANIA
PERCENT
CROP LAND
30-45
15-30
0-15
LAND USE
GENESEE RIVER
SUB BASIN MAP
JUNE 1963

Plate J16

Table J3.--Crop yields in Land Resource Area 101 (Ontario Plain) and Land Resource Area 140 (Allegheny Plateau), 1959.

Crop	Unit	Yields per Acre	
		Ontario Plain LRA 101	Allegheny Plateau LRA 140
Corn grain	Bushel	56.0	56.0
Corn silage	Ton	9.6	10.3
Wheat	Bushel	31.0	26.0
Oats	Bushel	60.0	50.0
Alfalfa hay	Ton	2.3	2.2
Clover and Timothy hay	Ton	1.8	1.6
Potatoes	Cwt.	185.0	210.0

Source: Adapted from the 1959 Census of Agriculture

Farm Characteristics

Type of Farming. Dairy is the major type of farming in the Genesee River Basin, although field crop, vegetable and fruit farms are important in the Ontario Plain. Percentages by type for the Basin are as follows:

Type of Farm	Percent of All Farms
Field crop	8.1
Vegetable	4.6
Fruit	3.7
Poultry	5.2
Dairy	78.4

Size of Farms. In 1959, the average size of farms in the Allegheny Plateau was 199 acres, of which 71 acres were cropland harvested. Farms in the Ontario Plain increased in size from 148 acres in 1949 to 184 acres in 1959 with an increase in cropland harvested from 77 acres in 1949 to 97 acres in 1959.

Number of Farms. In 1959, there were an estimated 5,279 commercial and non-commercial farms in the Genesee River Basin. The separation of commercial[1] from other farms[2] identifies two groups of farms with significant economic and operational differences. In the Allegheny Plateau there were 2,977 farms, of which 1,992 or 67 percent, were classified as commercial farms in 1959. In the Ontario Plain there were 2,302 farms, of which 1,586 or 69 percent were classified as commercial farms.

Sales Per Farm. In the Allegheny Plateau 843 commercial farms had gross incomes of $10,000 or more, 648 had incomes of between $5,000 and $9,999 and 501 had less than $5,000 in 1959. In the Ontario Plains 833 commercial farms had gross incomes of over $10,000, 397 had incomes of between $5,000 and $9,999 and 356 had less than $5,000 in 1959.

The gross incomes from sales in counties located in the Ontario Plain averaged $10,350 per farm, while the income from sales in counties located in the Allegheny Plateau averaged $7,840 per farm for 1959.

While comparable data is not available for the Basin, the importance of farms with gross receipts of over $10,000 is indicated by the information for New York State. In 1959, 43 percent of New York State's commercial farms (31 percent of all New York farms) had gross receipts of over $10,000 from the sale of agricultural products. Production on these farms was 76 percent of the total value of all products sold from commercial farms and 74 percent of the value of all farm products sold from all New York farms. Non-commercial farms were 31 percent of all New York farms but produced only 3 percent of the total value of farm products sold. The remaining 38 percent of farms sold 23 percent of the agricultural products and had gross sales between $2,500 and $10,000.

1/ Commercial farms include all farms with value of farm products sold of $2,500 or more.

2/ Other farms include part-time, part-retirement and abnormal farms.

Investment in Land and Buildings. Commercial farms in New York with gross receipts of over $10,000 have larger investments in land and buildings per farm and per acre, more hired labor per farm, and use cropland more intensively than those with smaller sales volume. The average value of land and buildings per farm and per acre reflects, to a large extent, the productivity of land found in the two Land Resource Areas. The average value of land and buildings per acre is almost two and one-half times greater in the Ontario Plain than the average value in the Allegheny Plateau. The average value of land and buildings per farm and per acre for 1949, 1954, 1959 is shown in Table J4. The differences in value partially account for the projections that show a decline in production in the Allegheny Plateau and an increase in the Ontario Plain.

Table J4.--Average value of land and buildings per farm and per acre, Genesee River Basin, 1949, 1954, 1959 1/

Land Resource Area	Average value per farm			Average value per acre		
	1949	1954	1959	1949	1954	1959
	----------Dollars----------					
Genesee River Basin						
Allegheny Plateau	8,202	11,097	16,692	51.83	65.57	88.07
Ontario Plain	13,386	20,140	33,796	115.49	150.68	215.63
Basin average	11,290	16,477	26,753	86.18	111.76	157.23

1/ Based on a sample of farms.

Population and Employment

Agriculture. Population estimates were developed for the Genesee River Basin by economic areas but only for the portion of the economic area within the Basin. In 1960, nearly 5 percent of the population was rural farm and nearly 18 percent was rural non-farm. Population data is shown in Table J5.

Estimated labor requirements for 1959 were developed by applying labor factors to Census of Agriculture production figures and are shown in Table J6.

Forest-based Industry. All material on present and future employment and production in forest-based industries appearing hereafter in this report is abstracted from the report "Projected Employment and Production in the Forest Industries in Economic Areas of the Genesee River Basin" prepared by the Forest Service for the Corps of Engineers in March 1965. For methodology used and assumptions made in deriving the following material, see that report.

A distinction is made between three-digit Standard Industrial Classification (SIC) industries engaged in the manufacture of primary products and those engaged in the production of fabricated secondary products. Industry groups are classified as primary or secondary manufacturing according to the following definitions: A primary industry is one which undertakes the first major processing of the basic raw material of the industry. In the forest products industry the basic raw material is considered to be logs, and the major processing consists of converting these logs to such products as lumber, pulp, and paper. A secondary industry, on the other hand, converts the final product of a primary industry to a more highly fabricated product. Thus, secondary products are sash and doors, plywood, etc. and secondary paper products are paper boxes and containers.

Table J5.--Estimated urban, rural farm and rural nonfarm population by portion of Economic Area within the Genesee River Basin, 1960

Economic Subarea	Population
	Number
Metropolitan Subarea	
Rural farm	4,261
Rural nonfarm	36,220
Total rural	40,481
Urban	263,888
Subarea total	304,369
Barge Canal Subarea	
Subarea total	189
Central Plain Subarea	
Rural farm	11,460
Rural nonfarm	28,690
Total rural	40,150
Urban	42,790
Subarea total	82,940
Allegheny Plateau	
Rural farm	5,320
Rural nonfarm	10,320
Total rural	15,640
Urban	20,320
Subarea total	35,960
TOTAL	423,458

Source: Adapted from 1960 Census of Population

Table J6 Labor Requirements in Man Hours, with Percentage Distribution for Major Products, Genesee River Basin, 1959.

Product	Total Hours	Percent
Hay	1,895,200	12.4
Beef and Veal	809,700	5.3
Milk	8,307,000	54.4
Oats	624,700	4.1
Wheat	469,000	3.1
Potatoes	551,200	3.5
Vegetables	711,300	4.7
Other	1,908,000	12.5
Total	15,276,100	100.0

Source: Developed from 1959 Census of Agriculture Production Figures.

The classification adopted is:

	Primary Segment SIC 1/ Code	Description	Secondary Segment SIC Code	Description
Lumber and wood products	241	Logging camps and logging contractors	243	Millwork, veneer, plywood and prefab. wood products
	242	Sawmills and planing mills	244	Wooden containers
			249	Wood products, NEC 2/
Pulp, paper and board	261	Pulp mills	264	Converted paper and paperboard products
	262	Paper mills		
	263	Paperboard mills	265	Paper and Board containers
	266	Building paper and board mills		

1/ Standard Industrial Classification
2/ Not Elsewhere Classified

Employment in the Lumber and Wood Products Industry in the economic area of the Genesee River Basin is tabulated below:

Sub-Area Economic	Primary Employment (SIC-241 & 242)		Secondary Employment (SIC-243,244,249)	
	Thousands			
	1950	1960	1950	1960
Barge Canal	1/	1/	0.5	0.4
Central Plains	0.1	0.1	0.3	0.3
Allegheny Plateau	0.7	0.8	0.5	0.5
TOTAL	0.8	0.9	1.3	1.2

1/ Less than 50 persons.

The total employment in the primary and secondary sectors of the lumber and wood products industry in the Genesee River Basin was 2100 persons in 1960.

Employment in the Pulp and Paer Manufacturing Industry in the economic subareas of the Genesee River Basin is tabulated below:

Economic Sub-Area	Primary Employment (SIC 262,263,266)		Secondary Employment (SIC 264 & 265)	
	Thousands			
	1950	1960	1950	1960
Barge Canal	0.2	0.2	2.3	2.3
Central Plains	0.2	0.2	0.8	0.8
Allegheny Plateau	-	-	0.5	0.5
TOTAL	0.4	0.4	3.6	3.5

The total employment in the primary and secondary sectors of the pulp and paper manufacturing industry in the economic area of the Genesee River Basin was 4,000 in 1950 and 3,900 in 1960.

Total employment in the lumber and wood products (SIC-24) and pulp and paper manufacturing industry (SIC-26) in the economic area of the Genesee River Basin was 6,100 in 1950 and 6,000 in 1960. Employment in wooden furniture manufacturing (part of SIC-25) is substantial and is not included in the above total.

Agricultural Income

The income to agriculture includes the value of the sales from farms of crops, livestock, livestock products, horticultural products, and farm forestry products. The cash value of on-farm domestic consumption of farm products is quite low and was not included. (For New York, it was estimated as 6.5 percent of cash receipts in 1949, 3.9 percent in 1959 and 2.4 percent in 1962.) Agricultural income was estimated by using proportionate county income data as reported in the Census of Agriculture. The portions were determined from the agricultural activity (number of farms, acres in farming, cropland harvested, etc.).

Table J7 indicates the percentage distribution of the value of major crops and livestock groups in the Genesee River Basin for 1939, 1949, and 1959. Table J8 shows the distribution by Land Resource Areas of the value of agricultural production for the years 1939, 1949 and 1959. Note that only the total value of production has been adjusted to 1959-1961 price levels. Price indices are not available for fruit, vegetables and other crop and livestock products so that they could be adjusted. Table J9 gives the percentage distribution by Land Resource Areas of the value of agricultural production for the years 1939, 1949 and 1959. Note the rapid increase in the value of dairy products, particularly in the Ontario Plain, where field crops were the major income source in 1939.

TableJ7.--Percentage distribution of agricultural income by major groups, Genesee River Basin, 1939, 1949, and 1959

Product	1939	1949	1959
	Percent	Precent	Precent
Dairy	34.6	44.0	52.0
Poultry	7.5	6.1	4.8
Other livestock	12.5	13.8	12.9
Forest and horticultural 1/	4.8	5.4	4.6
Fruit	1.1	0.8	2.4
Vegetables	9.0	6.8	5.3
Field crops	30.5	23.1	18.0

1/ This item includes forest products from farm ownership only.

Source: Adapted from the Census of Agriculture, 1959

Table J8. Value of agricultural production, by Land Resource Areas, Genesee River Basin, 1939,1949, and 1959.

	1939			1949			1959		
	Ontario Plain	Allegheny Plateau	Total	Ontario Plain	Allegheny Plateau	Total	Ontario Plain	Allegheny Plateau	Total
	Thousands of dollars								
Dairy Products	2,416	3,058	5,474	7,822	9,986	17,808	12,889	14,265	27,154
Poultry Products	603	584	1,187	1,308	1,148	2,456	1,105	1,393	2,498
Other Livestock	941	1,042	1,983	2,724	2,858	5,582	3,182	3,555	6,737
Forest & Horticultural 1/	512	245	757	1,416	766	2,182	1,553	873	2,426
Fruit	108	68	176	213	125	338	1,028	207	1,235
Vegetables	1,137	284	1,421	2,098	652	2,750	2,194	583	2,777
Field Crops	3,002	1,826	4,828	5,268	4,084	9,352	5,342	4,082	9,424
Total	8,719	7,107	15,826	20,849	19,619	40,468	27,293	24,958	52,251
Index of agricultural prices for New York 2/ (1959-61 - 100)	41	41	41	102	102	102	100	100	100
Value at 1959-60 prices	21,013	17,128	38,141	20,432	19,227	39,659	27,293	24,958	52,251

Source: Adapted from the Census of Agriculture, 1959.

1/ This item includes forest products from farm ownership only.

2/ Pearson, F. A. and Myers, W. I., Prices of Farm Products in New York State, Farm Economics No. 202, Department of Agricultural Economics, College of Agriculture, Cornell University, Ithaca, New York, December 1955.

TableJ9.--Percentage distribution of value of agricultural products sold, by Land Resource Areas, Genesee River Basin, 1939, 1949 and 1959.

	Ontario Plain			Allegheny Plateau		
	1939	1949	1959	1939	1949	1959
	Percent	Percent	Percent	Percent	Percent	Percent
Dairy products	27.7	37.5	47.2	43.0	50.9	57.2
Poultry products	6.9	6.3	4.0	6.2	5.9	5.6
Other livestock and livestock products	10.8	13.1	11.7	14.7	14.6	14.2
Forest and horticultural 1/	5.9	6.8	5.7	3.4	3.1	3.5
Fruit	1.2	1.0	3.8	0.9	0.6	0.8
Vegetables	13.8	10.1	8.0	4.0	3.3	2.3
Field crops	34.4	25.3	19.6	25.7	20.8	16.4

1/ This item includes forest products from Farm Ownership only.

Source: Adapted from the Census of Agriculture, 1959

Production

Crop and Livestock. Total agricultural production in the Genesee River Basin in a large measure is dependent upon the acreage of crops grown, the yields per acre, the number of livestock on farms and the production per animal. However, farmers in the Basin import fairly large quantities of grain and grain by-products from other areas in the United States and the quantity imported can be expected to increase in the future. This imported grain allows farmers in the Basin to greatly expand output of livestock and livestock products beyond the level which the use of Basin resources would allow.

Agricultural production for 1939, 1949 and 1959 in the Basin is summarized in Table J10 and more completely enumerated by products and land resource areas in Tables 19 through 32 in the Economic Base Study attachment. Percentage changes in the Basin's production and in the Middle Atlantic Region's production are given in Table J11. Among livestock and livestock product production, milk and cattle production increased, while hog, sheep and egg production declined.

In crop production from 1939 to 1959, corn harvested for grain increased substantially, while corn silage, hay, oat and wheat production increased to a lesser degree, but production of dry beans, potatoes, fruit and vegetables declined.

These trends in Genesee River Basin production followed the Middle Atlantic Region production with three exceptions. Hog and egg production increased and wheat production decreased in the Middle Atlantic Region.

However, the increase in corn grain production in the Middle Atlantic Region was minor compared to the very large increase in the Genesee River Basin.

Forest-based Industry. Production of lumber, paper and paperboard in the economic area of the Genesee River Basin is tabulated below:

Economic Sub-Area	Lumber 1950	Lumber 1960	Paper and Paperboard 1950	Paper and Paperboard 1960
	(Million Board Feet)		(Thousand Tons)	
Barge Canal	3.0	2.9	20	20
Central Plain	7.0	7.9	20	20
Allegheny Plateau	47.1	61.0	--	--
TOTAL	57.1	71.8	40	40

TableJ10.--Agricultural production, Genesee River Basin, 1939, 1949 and 1959

Commodity	Unit	1939	1949	1959
Whole milk sold	Mil. lbs.	348	430	639
Cattle and calves sold	Number	51,542	62,196	70.504
Hogs and pigs sold	Number	15,309	19,827	11,822
Sheep and lambs sold	Number	56,000	31,426	32,115
Eggs sold	Dozen	4,568,822	3,468,222	4,154,643
Corn harvested for grain	Bushels	442,624	735,557	1,423,599
Corn cut for silage	Tons	296,287	306,141	351,570
Hay harvested	Tons	281,916	252,910	379,047
Oats harvested	Bushels	3,392,846	2,409,497	4,153,469
Wheat harvested	Bushels	1,388,324	2,109,193	1,663,123
Dry beans harvested	Cwt.	438,805	376,793	255,553
Potatoes harvested	Bushels	2,953,347	3,881,558	2,187,356
Fruit harvested	Tons	30,094	21,273	18,172
Vegetables harvested	Tons	N.A.	85,950	83,580

Source: Adapted from the 1959 Census of Agriculture

Table J11.--Percentage change in agricultural production in the Genesee River Basin and the Middle Atlantic Region, 1939 to 1959

	Percentage change from 1939 to 1959	
	Genesee River Basin	Middle Atlantic Region
Livestock and livestock products		
Whole milk sold	+83	+63
Cattle and calves sold	+37	+42
Hogs and pigs sold	-23	+36
Sheep and lambs sold	-43	-17
Eggs sold	- 9	+53
Field crops		
Corn harvested for grain	+220	+12
Corn cut for silage	+19	+21
Hay	+34	+39
Oats	+22	+48
Wheat	+20	-23
Dry beans	-42	-32
Potatoes	-26	-14
Fruit	-40	-25
Vegetables	- 7	-17

Source: Adapted from the 1959 Census of Agriculture

Agricultural Water Use

The water used in the rural areas of the Basin for 1959 was estimated for four different groups or uses, (1) the domestic needs for both rural farm and rural non-farm population, (2) livestock use, (3) orchard spraying and (4) irrigation. Projections of future water requirements for these four uses appear later in the report.

The total water used in 1959 for livestock, orchard spraying and irrigation and in 1960 for rural domestic use was 2,704 million gallons. The percentage distribution was as follows:

Use	Percent
Rural Domestic	35
Livestock	43
Orchard Spraying	Less than 1
Irrigation	22

A discussion of each of these uses follows.

Rural Domestic Use. By agreement with the New York State Health Department, the responsibility for estimating water used for domestic water supply was as follows:

(a) New York State Health Department was responsible for water use and needs in all incorporated villages.

(b) New York State Health Department was responsible for Monroe County.

(c) New York State Health Department was responsible for needs and uses in small hamlets as shown on the water service units study as having water supply systems.

In general, New York State Health Department was responsible for all water use and needs data for areas having some type of organized water supply service units. U.S. Department of Agriculture was responsible for estimating the use and needs of those rural areas whose source is mainly from individually owned wells, springs or ponds.

Based on this agreement, estimated population not served by organized water supply service units appears in Table J12. The Basin population in Cattaraugus and Orleans Counties was too small to be significant and was not included. Domestic water use based on this estimated population is also shown in Table J12.

Livestock Use. The water used by livestock in 1959 is given in Table J13.

Table J12.--Water use by population not served by organized water supply service units, by county, Genesee River Basin, 1960.

County	Population[1]	Water used annually[2]
	Number	Millions of Gallons
New York		
Allegany	15,590	261,756
Genesee	9,760	163,870
Livingston	19,130	321,193
Ontario	3,570	59,940
Steuben	1,970	33,076
Wyoming	7,120	119,545
Pennsylvania		
Potter	1,450	24,346
Total	58,590	983,726

1/ U. S. Public Health Service, New York State Water Resource Commission and New York State Department of Health.

2/ 46 gallons per day or 16,790 gallons per year per capita.

Table J13 - Water used by livestock, Genesee River Basin 1959.

Type	Number	Daily 1/ Requirement Per Head (Gallons)	Total Daily Requirement (Gallons)	Annual Requirement (Million Gallons)
Milk cows	74,800	30	2,244,000	819.1
Calves and heifers	57,600	9	518,400	189.2
Steers, bulls and beef cows	15,800	12	189,600	69.2
Horses	3,000	12	36,000	13.1
Hogs and pigs	17,000	4	68,000	24.8
Sheep and lambs	44,300	2	88,600	32.3
Chickens	393,000	7/100	27,500	10.0
Broilers	962,000	2/100	19,200	7.0
Total Water Use			3,191,300	1164.7

1/ Source: (a) DeLaval Handbook, 1964; (b) Yearbook of Agriculture, 1955;
developed (c) Morrison's Feeds and Feeding, 21st Edition;
from: (d) U. S. Department of Agriculture Potomac River Basin Study.

Irrigation and Other Agricultural Water Uses. The use of water for supplemental irrigation is now considered to be a firmly accepted farm practice in the production of most vegetables and is being used to some extent on other crops in the western New York area. Farm lands growing irrigated crops in the Genesee River Basin and on the Ontario-Lake Plain Service Area make up a major part of the irrigation picture of western New York.

The "Report of the Temporary State Commission on Irrigation; 1957"1/ contains much valuable information concerning irrigation development in the area. The Report submits that as early as 1909, progressive farmers realized the losses suffered because of the periodic shortages of moisture for plant growth.

The practice of applying supplemental amounts of water for plant growth on a large scale is relatively new in New York State. It was not until the 1930's that farmers began to increase their interest in and use of irrigation. After World War II when aluminum became a plentiful substitutue for steel, lightweight quick-coupling irrigation pipe became available and was the key to increased use of irrigation in humid western New York.

Irrigation in upstate New York doubled from 1939 to 1949, and then tripled from 1949 to 1954. Farm land in the Genesee River Basin has been a part of this rapid acceleration. All counties within the Basin with the exception of Allegany, Steuben and Potter in Pennsylvania show increases in the use of irrigation from 1954 to 1959. No substantial areas have ever been irrigated in Potter or Allegany counties due to climate, soils and terrain. Genesee, Livingston and Monroe Counties are the leaders in terms of acreage irrigated. Acreages within Livingston County have almost doubled since 1954, while those in Genesee County have increased by approximately 60 percent. The rate of increase in Monroe County has been slower for primarily one reason, the tremendous urban expansion that has been taking place within the county and the competition for land has been keen. Crops most commonly under irrigation include the majority of the truck crops grown such as snap beans, cabbage, peas, tomatoes, sweet corn, etc.

According to the 1959 Census of Agriculture, Genesee County ranks third out of the 62 counties within the State in acres of vegetables harvested for sale. Monroe County ranks fourth and Livingston County ranks eleventh. The correlation between acres of vegetables harvested and acres under irrigation is quite high, leading to the belief that the use of water for supplemental irrigation is recognized as essential for the efficient use of resources in vegetable production. Again, using 1959 Census data, Monroe County ranks third in acres of land irrigated, Genesee County ranks sixth and Livingston County with its heavier textured lands ranks twentieth.

1/ "Report of the Temporary State Commission on Irrigation, 1957", Legislative Document (1957) No. 27, New York State.

The major source of irrigation water within the Basin lies in the surface water supply of the individual streams. A more detailed accounting of the sources of irrigation water is given in Table J14.

Table J14.--Acres Irrigated by Source of Water - Genesee, Monroe and Orleans Counties - 1959

Source	Genesee County Acres	Genesee County Percent	Monroe County Acres	Monroe County Percent	Orleans County Acres	Orleans County Percent
Wells	18	2.3	131	4.9	114	6.0
Natural streams & rivers	409	53.3	1,189	44.6	970	50.9
Springs & seepage	180	23.5	211	7.9	90	4.7
Farm runoff	2	0.3	255	9.5	20	1.0
Natural lakes & ponds	--	--	132	4.9	66	3.4
Drainage Ditches	159	20.6	3	0.1	10	0.5
Municipal Water	--	--	105	3.9	--	--
Other	--	--	644	24.2	638	33.5
TOTAL	768	100.0	2,670	100.0	1,908	100.0

Source: 1959 Census of Agriculture. Vol. IV, special reports, Part 2 Irrigation in Humid Areas.

As will be shown in later sections of this report, the lack of reliable water sources has been a deterrent to full development of irrigation potential within some areas of the basin.

This problem and those dealing with lands capable of being irrigated, land ownership, and the law are discussed under Irrigation on the Ontario Plains Service Area at the end of this report. The discussion is pertinent to both the Basin and the Service Area.

Because orchard spraying entails the use of such a small portion of the total agricultural water supply, no further description was made. The following table indicates its volume in relation to irrigation water use.

Table J15.--Water Requirements for Orchard Spraying and Irrigation in the Genesee River Basin 1959.

Activity	Number of Acres	Seasonal Requirements Per Acre (Gallons)	Total Requirements Per Season (Million Gallons)
Orchard Spraying	1,461	4,100 1/	6.0
Irrigation	1,830	325,850 2/	596.3

1/ Cornell University, Department of Pomology.

2/ Parker, M. L., The Potentialities of Irrigation From The New York State Barge Canal in Northwestern New York. Thesis presented to faculty of Graduate School of Cornell University, February 1955. It includes crop requirements, systems inefficiencies, and other losses in transportation and evaporation.

PRESENT LAND AND WATER RESOURCE PROBLEMS

FLOODWATER

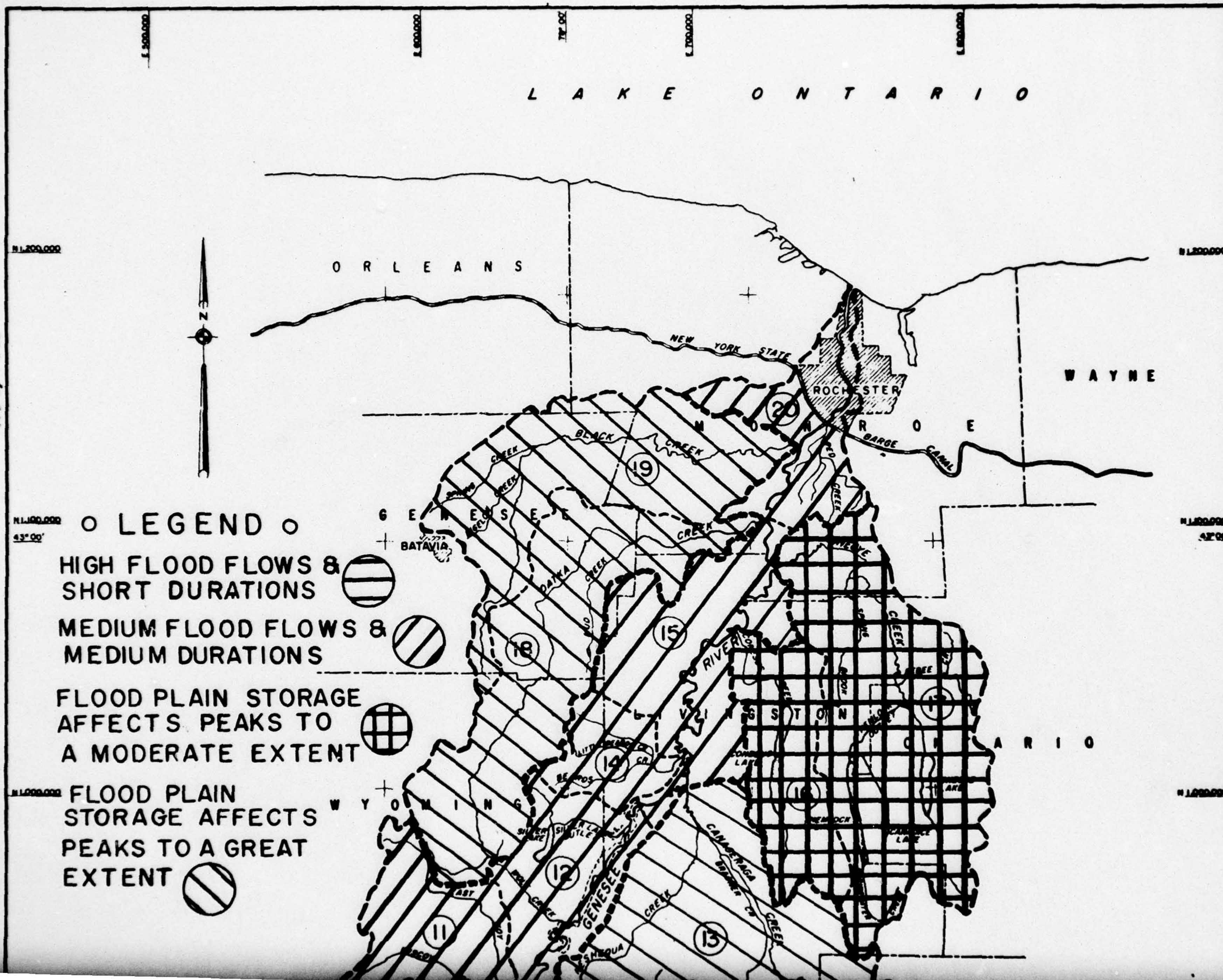
Flooding to some degree occurs in each watershed yearly regardless of their size, shape or flood characteristics. This section of the study describes the extent of floodwater problems by the various watershed areas. As introductory material to this section, reference is made to the hydrology portion of the report relating precipitation, temperature and runoff to distribution and availability of water. Plate J10 in the climatology write-up gives evidence of the high probabilities of some type of spring flooding over the Basin due to snowmelt. Plate J8 also provides evidence of the chance that frontal storms or thunderstorms will generate flood conditions during the summer months. This figure denotes the months of May, June and July as having the highest average monthly rainfall for both land resource areas. As noted from the graph, the average monthly rainfall of the Allegheny Plateau is consistently higher than that on the Ontario Plain. Although Plate J10 indicates that average runoff conditions are low during the high rainfall months, historical evidence is available which demonstrates the severity of summer type floods.

Plate J17 pictorially presents basic information relative to flood characteristics for each of the twenty upstream watershed areas.

To effectively measure the magnitude of floodwater problems within the Basin, field reconnaissance including interviews with knowledgeable persons, and searches through available historical literature were made for each of the twenty watersheds.

In conducting the flood damage survey, agreement was reached early in the initial phases as to responsibilities between the U.S. Department of Agriculture and the Corps of Engineers. The U.S. Department of Agriculture was responsible for evaluating all types of damages in watersheds 1 through 12. The Corps evaluated all urban damages in watersheds 14 through 20 and on the main stem of the Genesee River. The two agencies cooperated in the appraisals made for watershed 13. (See Plate J4 for location of the watersheds.)

In those watersheds where the field reconnaissance indicated flooding to be very minor, no concentrated effort was made to convert damages into monetary values. Physical facts and conditions were noted and cataloged for future reference. In those watersheds where field reconnaissance indicated flood conditions to be of a magnitude to warrant program evaluation, a concentrated study including determination of damageable values was made.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GENESEE
RIVER
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CANASERAGA
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○ LEGEND ○
HIGH FLOOD FLOWS & SHORT DURATIONS
MEDIUM FLOOD FLOWS & MEDIUM DURATIONS
FLOOD PLAIN STORAGE AFFECTS PEAKS TO A MODERATE EXTENT
FLOOD PLAIN STORAGE AFFECTS PEAKS TO A GREAT EXTENT

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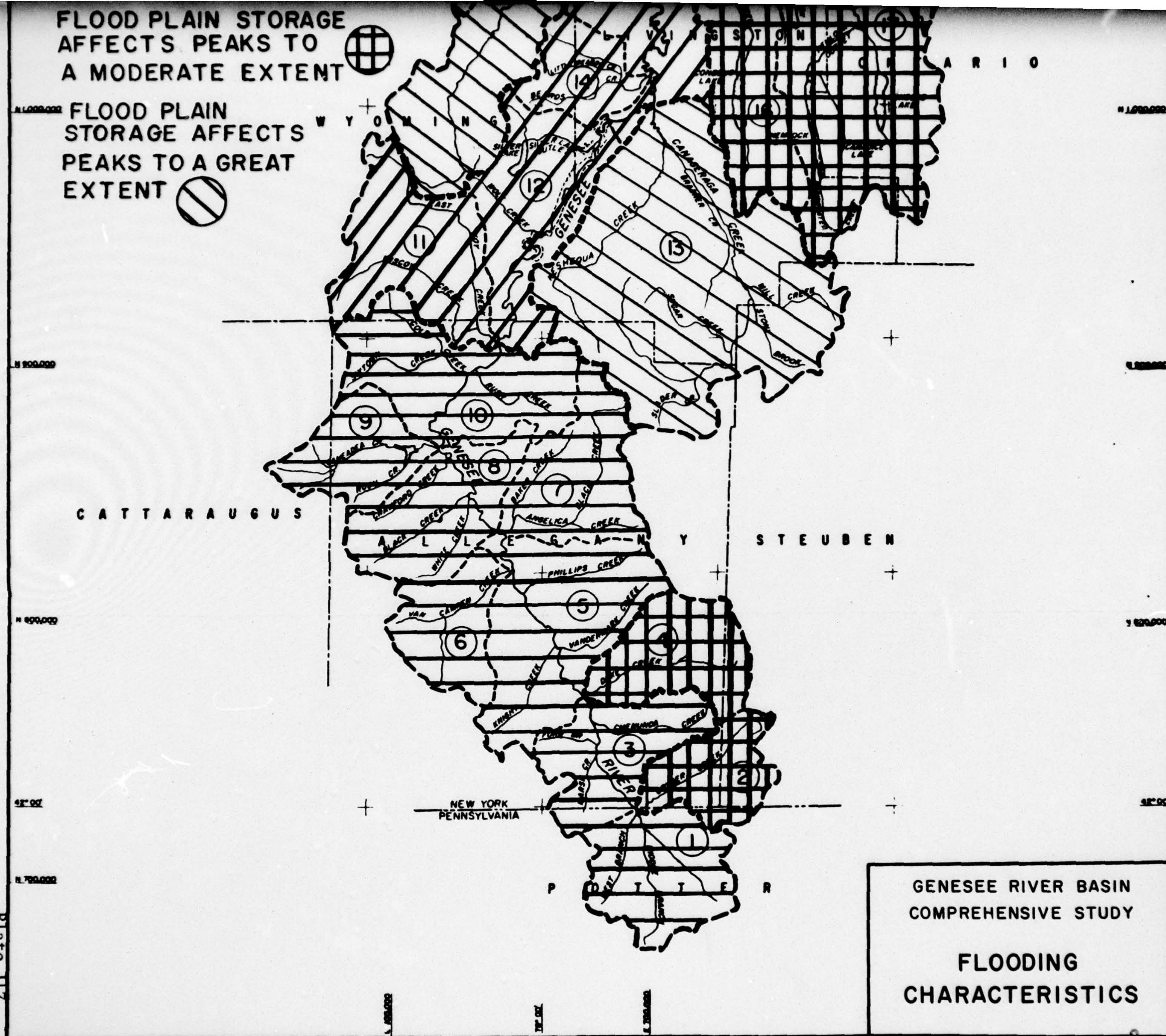
FLOOD PLAIN STORAGE AFFECTS PEAKS TO A MODERATE EXTENT
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ALLEGANY
STEUBEN
POTTER
NEW YORK
PENNSYLVANIA
GENESEE
RIVER
CANASERAGA CREEK
PHILLIPS CREEK
ANGELICA CREEK
SUGAR CREEK
STONY BROOK
42°00'
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
FLOODING CHARACTERISTICS

Plate J17

Floodwater damages in watersheds 1, 3-5, 8-10, 11, 12, 14-17, and 20 are considered to be minor and were not evaluated in monetary terms. Flooding to varying degrees has been or is now, evident within a number of these watersheds.

Yearly spring runoff produces out-of-bank flows along the narrow confined flood plains. Present use of the existing flood plain areas consists for the most part of woods, brush, permanent pasture and occasional acreages of hay or corn for grain or silage. As stated in the soils section of this report, the productivity of soils within those watersheds in the Allegheny Plateau area is not generally conducive to intensified flood plain use. Tributary streams within watersheds 12, 14 and 15 are well defined with little or no flood plain areas.

Where damages were determined to be significant a more thorough examination was made. The location of these areas is shown on Plate J18 and the frequency of damaging floods is shown in Table J16.

A brief description of the nature and extent of flood damages in these areas follows.

Watershed #2

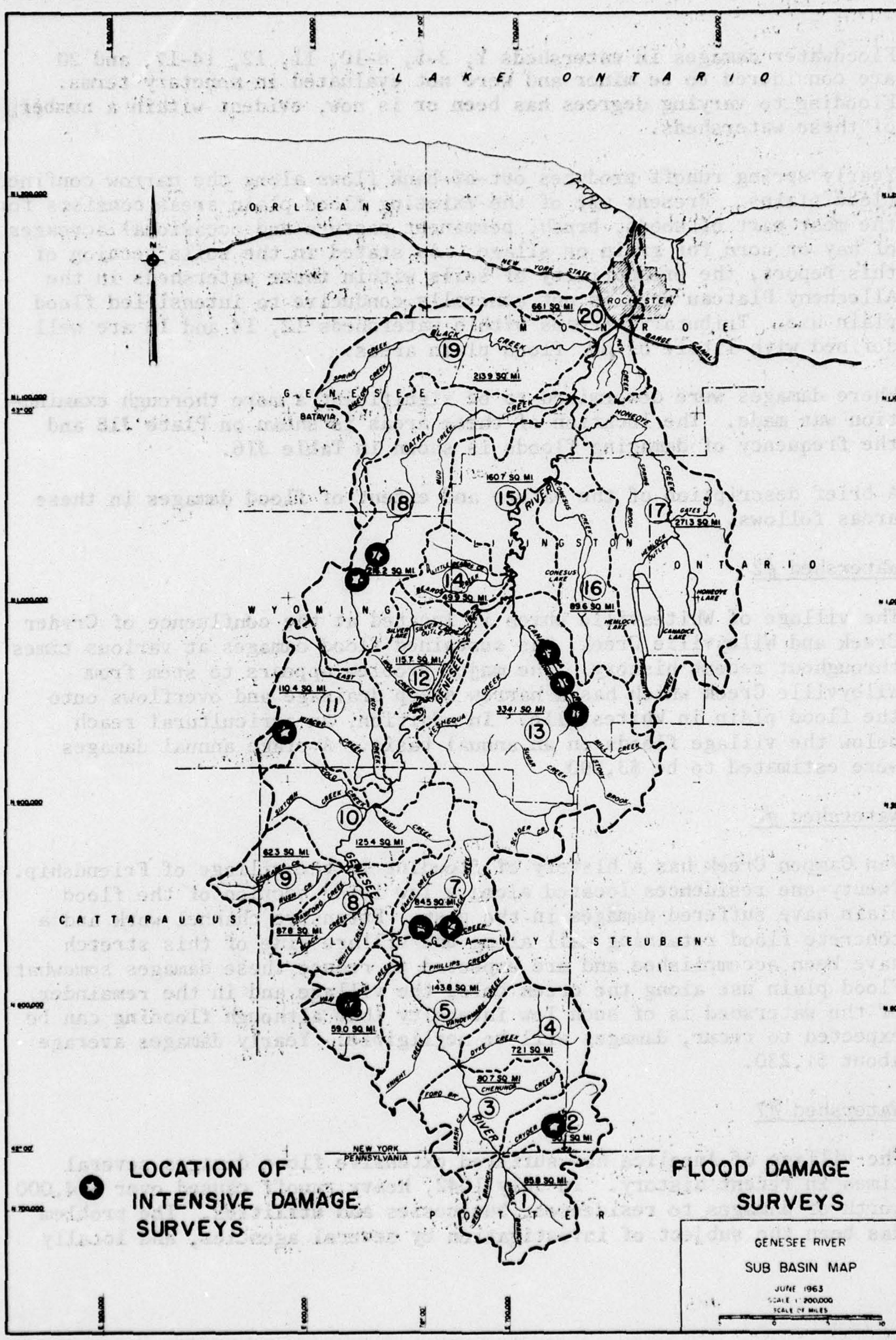
The village of Whitesville which is located at the confluence of Cryder Creek and Wileyville Creek, has sustained flood damages at various times throughout recent history. The major problem appears to stem from Wileyville Creek which has a narrow steep drainage and overflows onto the flood plain in Whitesville. In addition, an agricultural reach below the village floods on an annual basis. Average annual damages were estimated to be $3,990.

Watershed #6

Van Campen Creek has a history of flooding in the village of Friendship. Twenty-one residences located along a low lying section of the flood plain have suffered damages in the past. Extensive channel work and a concrete flood retaining wall along the village side of this stretch have been accomplished and are expected to reduce these damages somewhat. Flood plain use along the creek below the village and in the remainder of the watershed is of such low intensity that although flooding can be expected to recur, damages will be negligible. Yearly damages average about $1,230.

Watershed #7

The village of Angelica has suffered extensive flood damages several times in recent history. In July 1942, heavy runoff caused over $64,000 worth of damages to residences, businesses and utilities. The problem has been the subject of investigation by several agencies, and locally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STEUBEN
POTTER
NEW YORK
PENNSYLVANIA
CONESUS LAKE
HEMLOCK LAKE
HONEOYE LAKE
CANADICE LAKE
LOCATION OF INTENSIVE DAMAGE SURVEYS
FLOOD DAMAGE SURVEYS
GENESEE RIVER
SUB BASIN MAP
JUNE 1963

Table J16. Frequency of Out-Of-Bank Flows and Type of Damage in Rural Watersheds, Genesee River Basin

Watershed No.	Location	Percent Chance Of Annual Occurrence	Type of Damage
2	Whitesville	14	Residential
2	Whitesville	100	Agricultural
4	Andover	1	Residential
6	Friendship	20	Residential
7	Angelica	14	Residential
7	Black Creek	100	Agricultural
7	Baker Creek	33	Agricultural
11	Bliss	100	Residential
11	Pike	25	Residential
13	Canaseraga Valley	100	Agricultural
18	Warsaw	100	Agricultural

there has been some effort to clear the channel of the creek. Agricultural damages in the area have been slight due to the generally low level of utilization of the flood plain but it is expected that these and the urban damages will continue to occur unless more effective remedial measures are taken. Average annual damages are estimated to be $7,800.

Watershed #11

Residential floodwater damage can be expected to occur in the village of Bliss where Wiscoy Creek creates a two-pronged problem. A rainfall-runoff flood expected to occur once in 100 years would cause damages to approximately eight residences and two businesses. This results in a very low average annual damage value even though one residence is flooded almost annually. More frequently, ice floes block the bridges over the stream channel and cause flooding of about the same area as the 100-year rainfall flood. Flooding in the remainder of the watershed inundates only land of low intensity use and causes no damages of any magnitude.

Watershed #13

The area of perhaps the greatest continuing concern with respect to agricultural flooding in the Genesee River Basin is Canaseraga Creek. The flood plain is an area of about 11,500 acres in the east central portion of the Basin. It was determined that 6,700 acres flood every other year while about 9,800 acres flood on a 10-year frequency. The flood plain is utilized quite intensively even with the present flood hazard and crops of all types such as nursery stock, vegetables, corn for grain and silage, hay and pasture are grown there. Photo 3 shows spring flooding in this watershed.

Annual spring runoff causes damages to the overwintering nursery stock and lowers yields of other crops due to late planting. Summer rainfall flooding, though of lesser frequency, causes considerably greater damages due to the higher value of mature or partially mature crops. Because of the annual nature of the problem, no residences or other structures have been located in the flood plain and damages from that source are non-existent.

Average annual floodwater damages are estimated to be $93,640. The productivity of the flood plain soils and the presence of an already intensive agricultural industry in the area indicate that flood plain utilization could increase substantially if the frequency of flooding were reduced.

Watershed #18

Flooding from Oatka Creek between the villages of Warsaw and Pearl Creek causes some fairly extensive damages to potentially valuable agricultural land. Of the total 1,900 acres in the flood plain, 1,100 are flooded annually, 1,500 on a two-year frequency and nearly 1,800 by a ten-year event. Cropping patterns are not nearly as intense as those on the

Photo J3
Extensive agricultural flooding along Canaseraga Creek

Photo J4
Agricultural and residential flooding along Black Creek

Canaseraga, but do include some cash crops such as snap beans and other vegetables as well as corn, small grains and hay. Again, spring runoff flooding causes the major portion of the flood damages which are estimated to total $6,000 annually.

Additional flooding occurs on less productive land below this reach resulting in small damages. However, a fairly extensive tract of land near the confluence of the Genesee River and Oatka Creek suffers heavy losses due to a combination of the effects of both water courses. Both this tract and the tract below Warsaw are potentially capable of being utilized more intensively than at present.

Watershed #19

The Black Creek Watershed suffers from considerable flooding of an urban and an agricultural nature. The problem is unique in that the damages are concentrated in the lower portion of the watershed and are caused mainly by flooding on the main stem of the Genesee River. Urban expansion from the Rochester complex has generated the major portion of the damages and because the flood plain is clear, flat and accessible to the city, damages are expected to increase. Photo 4 shows flooding from Black Creek.

The summary of average annual floodwater damages as appraised by the U. S. Department of Agriculture is given in Table J17.

Table J17. Estimated Average Annual Floodwater Damage by Watershed Within the Genesee River Basin as Appraised by the Department of Agriculture, 1966.

Watershed	Estimated Average Annual Damage
#2	$ 3,990
#6	1,230
#7	7,800
#11	4,650
#13	93,640
#18	6,000
TOTAL	$117,310

EROSION AND SEDIMENT

The geologic process of erosion and its product, sediment, become problems when and where their occurrence conflicts with the interest and activities of man. These processes then, under many conditions, are intensified by the very activities for which they are problems.

The rate at which the soil erodes is accelerated by working the soil for crop production, while crop yields are lowered by the loss of fertile soil due to sheet erosion. Moreover, off-site or downstream damages result from lowered water quality and sedimentation.

The purpose of this section is to briefly describe the erosion and sedimentation problems that presently exist in the upstream watershed areas of the Basin. Studies consisted of field observations in each of the twenty watershed areas. Extensive sampling procedures were not employed nor were extensive quantitative estimates made in the appraisal.

Erosion from Urban and Road Development

In the areas undergoing rapid urban development, gully erosion is developing where the topsoil and vegetation have been stripped off and should be carefully controlled before a serious problem develops. The lack of cover increases the volume of runoff and decreases the time of concentration causing a great deal of erosion as more urban development continues. This indicates a problem which may become one of the more serious erosion hazards in the Basin.

In addition, unsurfaced roads which were poorly located and which are poorly maintained contribute excessive amounts of sediment. Included are logging roads and logging skid trails. While these sources of sediment production may be minor in comparison with other sources mentioned above, opportunity for economically feasible improvement exists.

Streambank Erosion

Streambank erosion occurs throughout the Basin in most upstream areas. The most common occurrences are at bends in the stream and at bridge crossings. Damage occurs mainly to low value land in the upstream watershed areas, and through lowered water quality and increased sediment deposition downstream. Some exceptions to the low valued land damage can be found; the most noticeable of these are as follows: Black Creek in Watershed 5 near its mouth is cutting into a farmyard endangering a barn and a number of other farm structures. Phillips Creek also in Watershed 5 slightly upstream from Belmont is cutting toward a number of farm appurtenances. Streambank erosion in the Angelica Creek Watershed 7, as evidenced by Photograph J5 below, is seriously endangering a number of residential properties.

Extensive streambank erosion to higher value land occurs along the entire length of the Genesee River. The meandering nature of the river exposes the banks in many places to the eroding action of the water. Cropland and pasture along the main stem of the River in Watersheds 3,5,8,9,10,15 and 20 is being lost through stream cutting. These conditions have been described in greater detail by the Corps of Engineers.

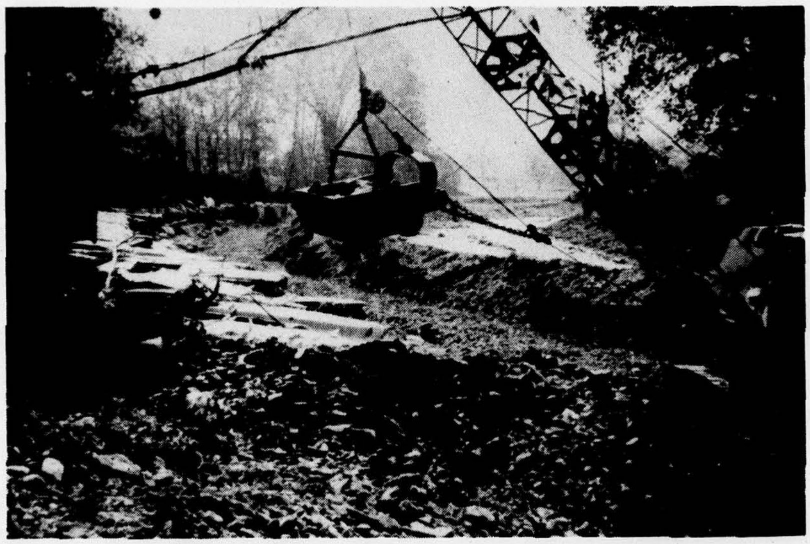

Photo J5 Critical streambank erosion and control attempts on Angelica Creek

Gully Erosion

Areas of extensive and serious gully erosion were not noted. Lands in the northern part of the Basin, primarily on the Ontario Plain where more intensive farming is practiced, have minor gullies forming. However, these are not considered serious and do not constitute an obvious land feature. Evidence of past gullying in the Allegheny Plateau area is noticeable, but much of the problem no longer exists since on-farm improvements and changes in land use tend to keep new gullies from forming. One of the more significant of these changes is the widespread abandonment of farmland with its subsequent reversion to a forest cover,

Infertile Overwash

Very little infertile overwash is deposited on any of the cropland in the Basin. Local occurrences have been observed where streams emerge from high gradient areas. Watershed 13 in the Canaseraga Valley and Watershed 5 near Belmont have a minor problem of coarse grained material being deposited on high value land such as nurseries and urban areas.

Sheet Erosion

Generally moderate sheet erosion occurs throughout the Basin. Calculations based on the "Universal Soil Loss Prediction Equation"1/ show that the silty soils of the Caneadea-Canaseraga Association have consistently higher rates of soil loss, although the amount is below the maximum acceptable loss of 3.0 tons per acre per year. Lower rates of soil loss occur from the coarser textured soils.

An important factor in the amount of sheet erosion which occurs is the land use. Where intensive cropping patterns are used, where cover conditions are poor or where the land is undergoing a change in use, erosion is more severe. Urban construction in Watersheds 15,16,19 and 20 is disturbing the protective cover and large volumes of soil are being lost. Amounts of soil which are lost also depend on steepness and length of the slope and amounts of rainfall.

Conversely, areas with adequate soil cover suffer little from erosion and contribute little sediment if protected from fire, over-grazing, destructive logging methods, and other cover-destroying practices. The portion of the Basin contributing the smallest relative amount of sediment is the 27 percent which has a forest cover. Most of the forested areas are found on the steeper slopes and shallower soils.

1/ The Universal Soil Loss Prediction Equation is a method of determining the amount of soil lost through erosion by various types of soil utilizing the physical character of the soil, topography and precipitation.

These sites, without adequate cover would be subject to severe erosion, the most critical from the standpoint of sediment production, and therefore merit special consideration and protection.

Although there are local areas where sheet erosion is a problem, the Basin as a whole is not severely affected.

DRAINAGE NEEDS

In total, there are about 108,000 acres of land in the Basin which could be benefited to some extent by drainage. The total includes both large areas and small on-farm areas of wet soils. This section of the report will concentrate on the large contiguous areas which necessitate group type facilities. The remaining area will be considered in the section pertaining to land treatment.

Much of the land having poor internal drainage is subject to flooding which further limits the nature of its use. Because flooding limits the intensity of crops which can be grown, the cost of supplying drainage is often greater than the returns which could be expected. Therefore, landowners are apt to keep the land in pasture or other low intensity uses. In addition, a lack of outlets for drainage systems often exists in these flood plain areas.

Some areas, notably in the northern watersheds, do have extensive areas which could benefit from a systematic drainage program. These are broad flat flood plains farmed to varying degrees of intensity and subject to some degree of spring flooding on an annual basis. In these areas drainage is closely associated with flood control.

One such area is the Canaseraga Valley below Dansville. This land consists of about 11,500 acres used for the growth of nursery stock, specialty vegetable crops and field crops. Due to the inherent productivity of the land, a satisfactory drainage system would enable landowners to increase their net income by allowing earlier working of the fields, increased yields and more intensive use of those areas now in field crops.

Oatka Creek below the village of Warsaw flows through a similar but smaller valley with the exception that the land is not used nearly as intensively as the Canaseraga Valley. About 2,000 acres of land in this area could be enhanced by adequate drainage involving a group action project. A considerable parcel of land in the lower portion of the Oatka Valley near its confluence with the Genesee River also would benefit from drainage. This area is a portion of a large strip of land running along most of the lower Genesee River where the soils are moderately to highly productive but suffer from poor drainage.

The Black Creek Watershed contains the third major area of drainage needs. Extensive flats in the town of Chili along Black Creek suffer from impaired drainage and flooding problems. The dominant problem here is the flooding however, since the land would go rapidly into suburban residential development in the absence of that restriction. Should the flooding problem be corrected, recognition should be made of the drainage needs before extensive residential development occurs.

In addition to the above areas in the Ontario Plain, smaller areas in the southern watersheds suffer from drainage problems. In particular, watersheds 2 and 4 contain 480 acres each of poorly drained bottomland soils. Because outlets are very difficult to obtain, much of the land is in tame hay and pasture trending to brush. Little change is expected in this use pattern.

POLLUTION CONTRIBUTED BY AGRICULTURE

Major sources of water pollution from farm activity are pesticides, fertilizer and sediment from soil erosion. A brief discussion of these problem areas follows. Appendix Tables A-9 through A-18 present some data on agricultural pollution.

Pollution Contributed by Use of Pesticides

Twenty-five years ago the recommended pesticides were few in number, and made from simple inorganic and botanical derivities. Today there are many pesticides which are complex chemicals and synthetic organic compounds. Many insects and plant diseases are now controlled that were problems twenty-five years ago. Selective chemical weed control, then an unknown method, is now a commonplace practice. Recognition of the hazards associated with the use of pesticides has led to the development of less toxic compounds. Insecticides that are more readily broken down into nontoxic components and pesticides that are more specific for an individual pest rather than broad spectrum materials that can kill desirable species along with the pest are coming into wider use. The number of pesticides and the quantity produced have grown steadily.

More common pesticides are insecticides, herbicides, fungicides and nomatocides. The insecticides are particularly toxic to fish. They may also cause death among birds and mammals, either by direct contact or intake or by concentration of the toxic compound by various species in a food chain. The insecticide may be lethal anywhere along the food chain.

The trend away from broad spectrum materials toward more specific controls for insects, plant diseases and weeds is expected to continue. Consideration will be given to avoiding crop injury, environmental contamination and preserving natural control factors. There will be a continued effort to develop alternative methods of pest control.

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GENESEE RIVER BASIN COMPREHENSIVE STUDY OF WATER AND RELATED LA--ETC(U)
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Pollution Contributed by the Agricultural Use of Fertilizers

The use of fertilizer on crops contributes to pollution by adding nutrients to the surface waters by either runoff, erosion or percolation. Nitrogen and phosphorous compounds are of major concern. They contribute to the growth of various algae forms. Algae can be a nuisance in several ways. Algae in the water supply can contribute to foul odors and taste. In recreation waters, decaying algae masses create obnoxious odors and kill fish by depleting the dissolved oxygen supply. The spreading of animal manure on farm land may contribute to pollution by adding nutrients or organic matter to the water course, either by erosion or occasionally by direct discharge into streams.

There has been a slight downward trend in the tonnage of fertilizer used on farms in New York from 1950 to 1959. This is a result of a decline in total crop acres rather than a decline in application rates. This followed a substantial upward trend between 1940 and 1950.

Pollution Contributed by Sediment and Erosion

Although sediment and erosion are a source of water pollutants from agricultural activity, the problem is not treated separately at this point but is covered under the section entitled, "Erosion and Sediment."

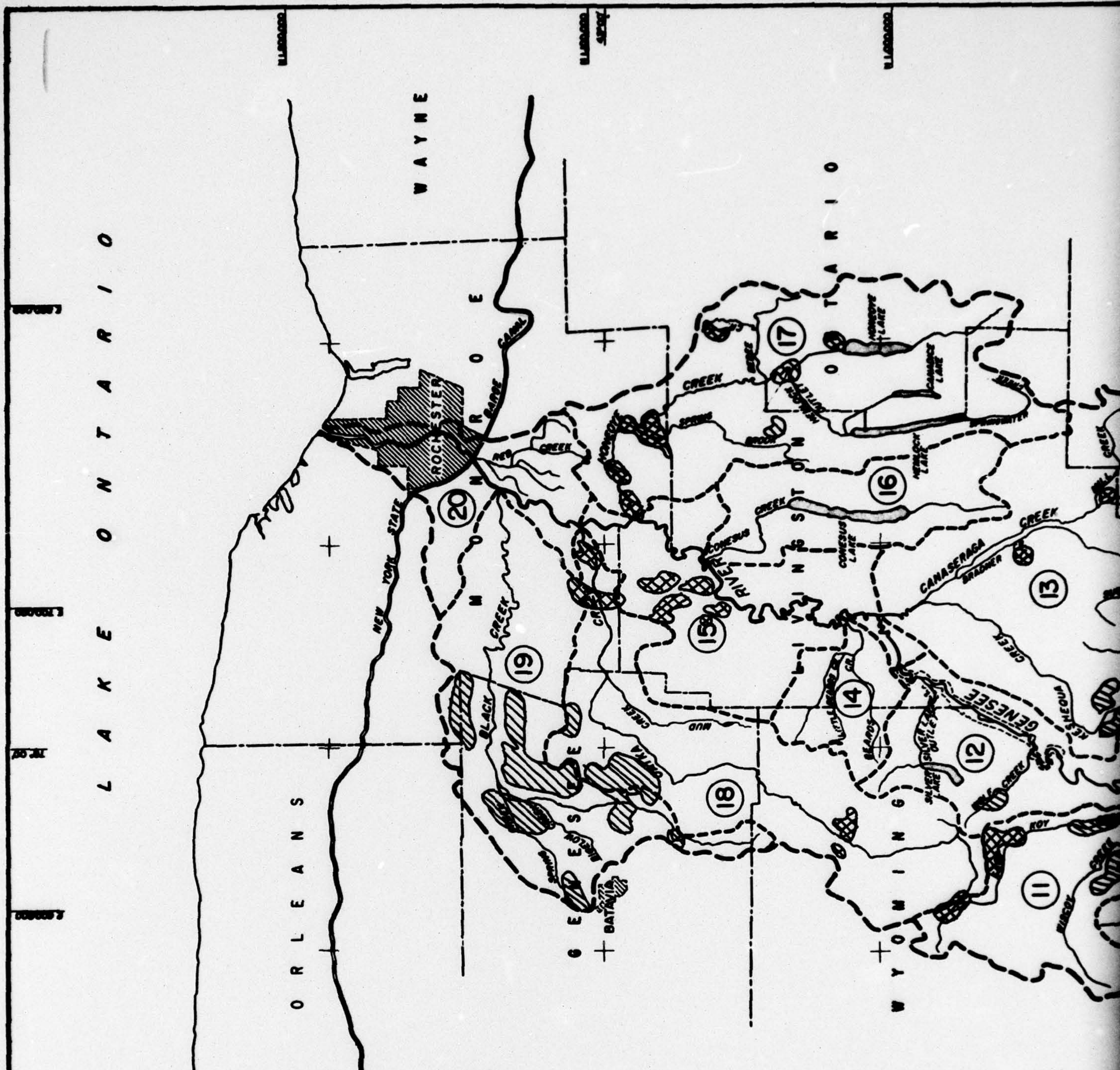
IRRIGATION

Currently, only a very small portion of the irrigable land in the Genesee River Basin is being irrigated. The 1964 Census of Agriculture, Preliminary Reports, indicate that about 5,900 acres were irrigated in the entire five-county Genesee River Basin Economic Area. About one-half of this total or 2,950 acres were located in the Basin proper. This is only six percent of the irrigable land in the Basin and less than two-tenths of one percent of the total land in the Basin.

The Genesee River Basin has about 49,600 acres of irrigable land, generally located in small scattered areas in the northern watersheds. Table J18 shows the irrigable land in each watershed within the Basin. It also indicates the type of drainage necessary to accomplish the irrigation. Plate J19 depicts the location and areal extent of the irrigable land.

With the exception of the 5,780 acres located in Watersheds 5 and 10, the irrigable land is generally situated in upland areas requiring no flood prevention measures.

Several sizable irrigable areas are located in Watersheds 11, 17 and 19. A small percentage of this irrigable land is presently being irrigated. The reasons for the small amount of irrigation currently undertaken are similar to those listed for the Ontario Lake Plains Service Area later in this report.



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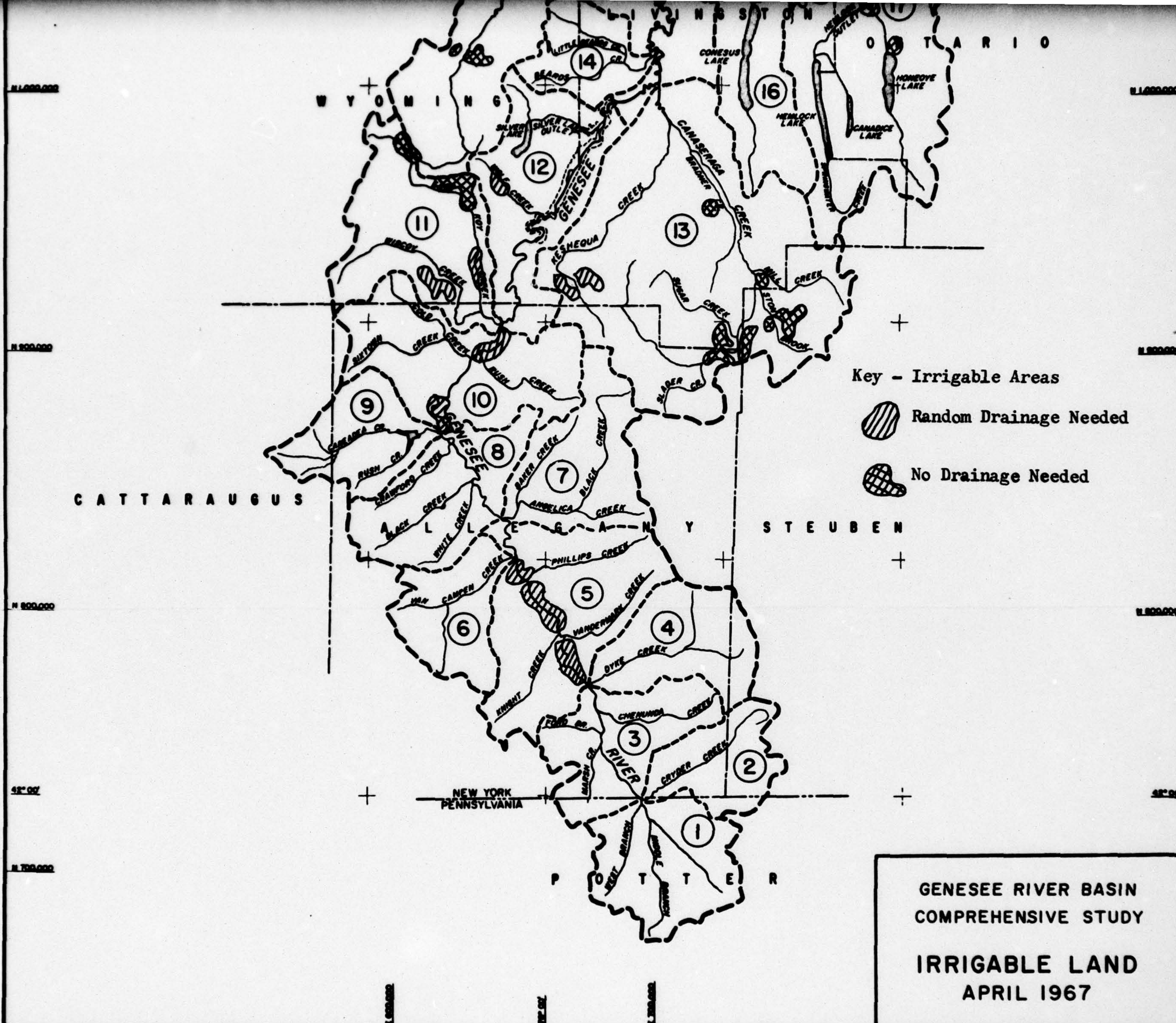


GENESEE RIVER BASIN
COMPREHENSIVE STUDY

IRRIGABLE LAND
APRIL 1967

Plate J19

Table J18. Irrigable Land in the Genesee River Basin by Drainage Needs

Watershed	Land Capable of Being Irrigated: No Drainage Needed (acres)	Random Drainage Needed (acres)	Total (acres)
5	--	3,780	3,780
10	--	2,000	2,000
11	2,240	2,280	4,520
12	--	610	610
13	2,390	1,200	3,590
15	--	9,150	9,150
17	2,920	290	3,210
18	3,100	3,920	7,020
19	540	15,140	15,680
Total	11,190	38,370	49,560

Source: Unpublished Soil Conservation Service data.

Although the total area now receiving supplemental water is small, the irrigation of potatoes and other specialty crops has increased greatly in the past several years. In many cases, local and on-farm water supplies have been developed. Some additional development of this type is yet possible, but a practical limit will be reached before all demands have been satisfied. This limit is especially applicable in those areas where irrigable land is concentrated in large tracts as in Watershed 19 where landowners have already indicated their interest in developing a group water supply.

Due to present crop rotation systems and the fact that much of the irrigable land in the Basin is rolling upland, it is likely that not more than 30 percent of the nearly 50,000 irrigable acres would be irrigated in any one year. If the areas located in small scattered plots and the areas having locally developed water sources are also separated from the total irrigable land, about 10,000 acres of land remain which could feasibly utilize group irrigation water supplies. It appears that the demand for this irrigation water supply will increase substantially during the next three decades.

OTHER AGRICULTURAL WATER SUPPLY PROBLEMS

There has been no indication that major problems exist with rural domestic water supplies. The drought of the last few years may have caused failures of inadequately developed springs and wells. In most instances this problem has been solved by drilling new wells to replace dry wells and springs.

However, a region near Perry and Perry Center in Wyoming County has had a continuing problem of failure of wells and resultant water shortages. It is possible that this region could utilize the service of an organized water supply system.

A similar situation exists for livestock. However, occasionally farms with very large herds, in areas where newly developed wells give low yields, may resort to very large storage tanks so that wells may be pumped more or less continuously or supplemented with farm ponds.

LAND RESOURCES

Land is a basic resource within the Basin. The proper management of this resource is essential if a sustained and productive economy is to be maintained. Land use patterns within the Genesee Basin are changing as in many other areas in the United States. The land resource is being subjected to more intensive use and a greater variety of uses.

From an agricultural standpoint the amount of land available for crop production has been and is continuing to be on the decline. Residential, industrial and similar type uses are competing for the more highly productive agricultural lands. More intensive use is being made on the

better agricultural land and this trend will continue. These lands will have to be managed in a more intensive manner in order to maintain their productive qualities. In this regard, it is important that a program be developed to assure the optimum protection and utilization of the land resource.

The results of improper land use and/or management are evident. Photo J6 shows some of the problems which can result.

One of the more significant and evident changes in rural land use in the Basin is the abandonment of farm land on the Allegheny Plateau and its reversion to a forest cover (see Photo J1 on page 17).

In 1900, 80 percent of the acreage of the five New York counties on the plateau was in farms. By 1959 only about half of this area was in farms, with the greatest rate of reduction following World War II. In the case of publicly-owned, and some privately-owned areas, this reversion has been through the planting of coniferous species, but the greater portion of the unused crop and pastureland is left to revert naturally, much of it to brush and thornapple (Crataegus Spp.) or to stands of low value and poor quality trees.

This abandoned farmland presents both a problem and an opportunity for conservationists as well as other residents of the Basin. It can be left idle, or efforts can be made to encourage management of these areas to produce optimum amounts of high quality water, timber, and recreational opportunities including hunting and fishing.

Another major resource problem is the difficulty of promoting good forest management practices on the small, privately-owned forest tracts. Photo J7 depicts a stand needing management. Approximately 80 percent of the forest landowners own less than 100 acres, 19 percent own 100 to 1,000 acres, and only 1 percent own over 1,000 acres. Speculation in land for recreational use provides a major ownership motivation, especially in the Allegheny Plateau and to a lesser degree in the Central Plain. From one-quarter to one-third of the small holdings are held by absentee owners. Another hindrance is the difficulty of profitable marketing of forest products from these smaller holdings.

Some additional specific problem areas are as follows:

a. Badly eroding oil lease roads in the Wellsville area of Allegany County are contributing sediment to and increasing peak flows of the streams. See Photo J8.

b. Overgrazing of forest land by cattle is scattered throughout the Basin but is more prevalent in Livingston and Allegany Counties.

c. An excessively large deer herd in the Allegheny Plateau subarea, especially in Potter County and portions of Allegany County is damaging the forest cover. In the areas of heaviest deer concentration, tree reproduction and shrubs are seriously overbrowsed and in many cases almost entirely eliminated from the understory. See Photo J9. It is extremely difficult for reproduction to become established in cut-over areas and many times openings are created which adversely affect watershed values. The Pennsylvania Game Commission is working to get the deer herd in balance with its available food supply. The Hammermill Paper Company, which owns approximately 50 percent of the forest land within the Basin in Potter County, encourages deer hunting on its lands in an attempt to keep the herd in balance.

Photo J6. Erosion and Stream pollution caused by improper land use

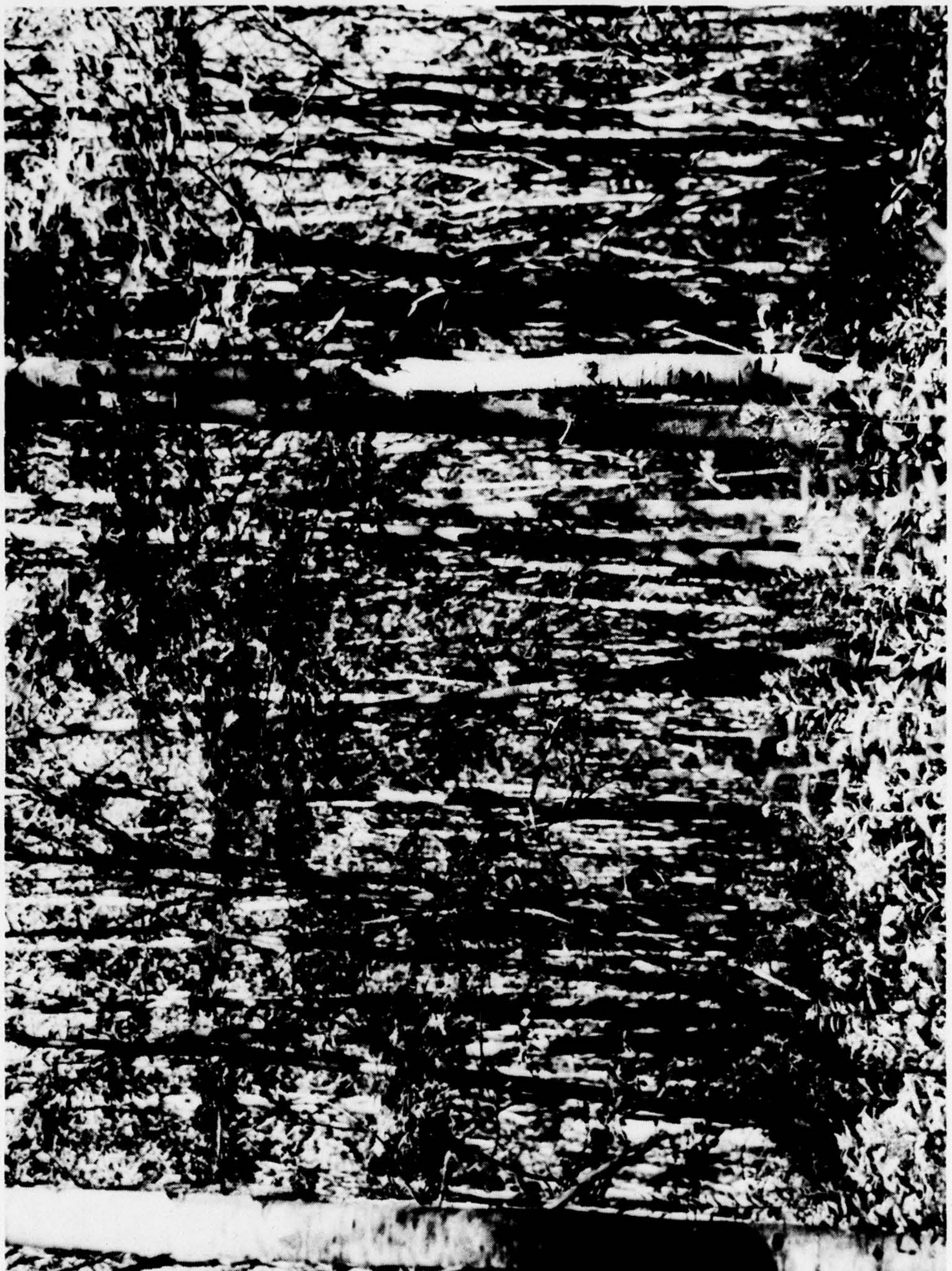


Photo J7. Volunteer stand in poor condition; needs thinning,
weeding and improvement cutting

Photo J8. Eroding oil-lease road

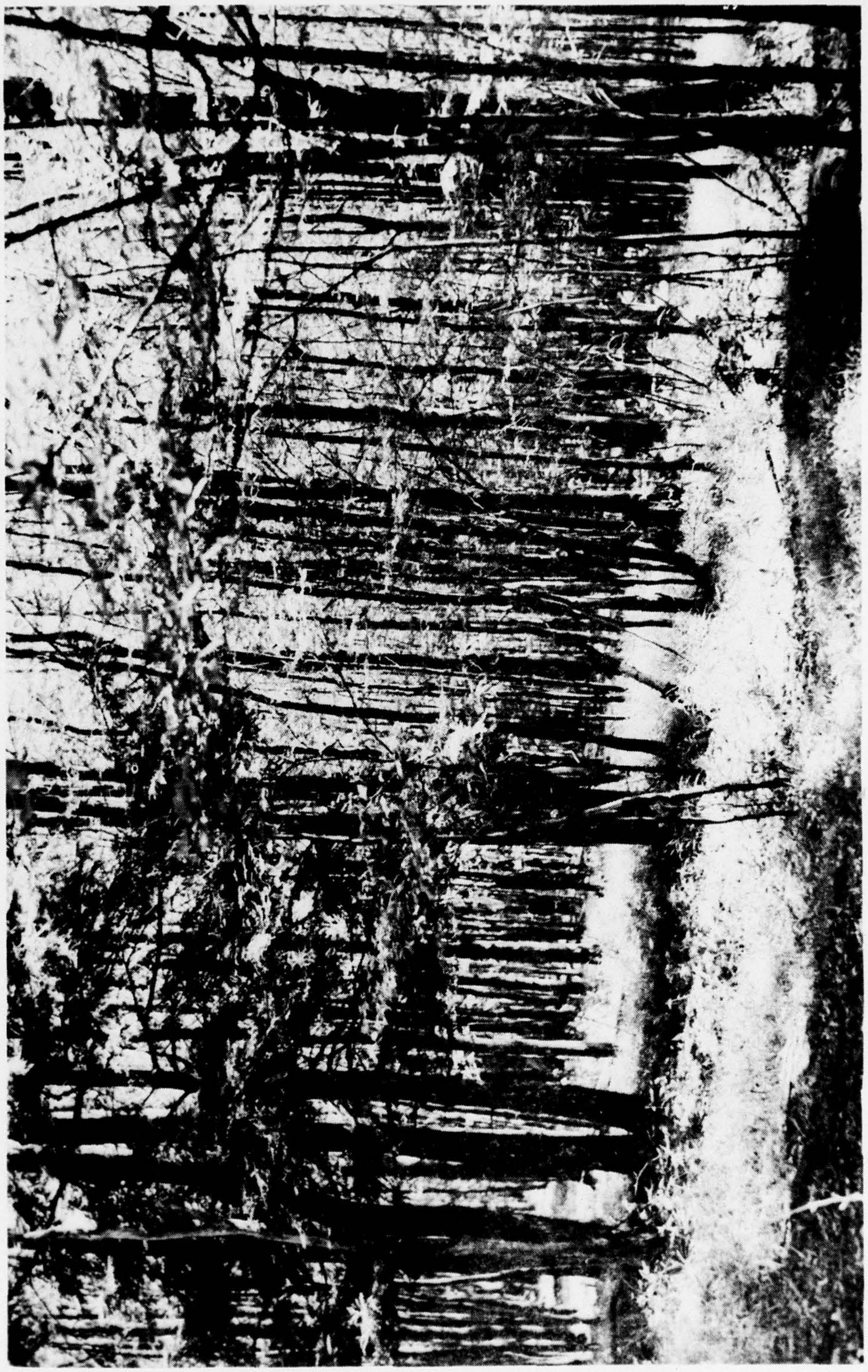


Photo J9. A young hardwood stand heavily over-browsed by deer

FUTURE LAND AND WATER RESOURCE NEEDS AND THE POTENTIAL OF THE BASIN TO MEET THESE NEEDS

POPULATION, PRODUCTION & EMPLOYMENT

Rural population and agricultural employment

Population projections were developed to serve in making estimates of water requirements and water pollution problems. Instead of the usual distribution between rural and urban categories based on the Census of Population definitions, the breakdown here is on population served by central water supply service systems and those not served (Table J19). "Generally, the population served by a central water supply system was projected on the basis of that portion of the village, hamlet or town now served by a public water supply system. The present population served by a central water supply system was projected to the future in the same ratio as the projected growth of the town as indicated in Population and Employment Projections, 1970-2020, Genesee River Basin Economic Base Study, Phase II.[1/] The present population served by a central water supply system has been extended into the future in areas in which the above system indicated a downward trend."[2/] Note that the small numbers of people in that portion of the Basin, Cattaraugus and Orleans Counties have not been included.

The New York State Department of Health has assumed responsibility for the water problems of Monroe County and, therefore, no data is given for that county. If those people not served by central water supply systems are considered as rural, the above method reduces the rural population when compared to the methods of classification used by the 1960 Census of Population[3/] by about 23,000 people.

Future labor requirements on farms (Table J20) were estimated by applying projected hours of labor required for various items of agricultural production to the projections of agricultural output. The result is a projection of the total hours of labor required during a year. The number of persons these hours of labor represent was not estimated.

1/ Division of Water Resources, New York State Conservation Department, July 1965.

2/ Letter from the New York State Department of Health, May 9, 1966.

3/ Those in villages of 2,500 people or over are considered as urban; all others are considered as rural.

Table J19.--Population Served by Central Water Supply Service Systems and by Individual Private Systems, Genesee River Basin, 1960, and Projections by Decade From 1970 to 2020.

County and Source	1960	Projections 1970	1980	1990	2000	2010	2020
				Number			
NEW YORK							
Allegany							
Public	14,920	15,080	15,100	15,460	15,830	16,050	16,270
Private	15,590	15,820	15,820	16,300	16,550	17,180	17,580
	30,510	30,900	30,920	31,760	32,380	33,230	33,850
Genesee							
Public	6,020	6,860	7,550	8,200	8,930	9,610	10,290
Private	9,760	12,050	14,050	16,600	19,050	21,740	24,230
	15,780	18,910	21,600	24,800	27,980	31,350	34,520
Livingston							
Public	24,420	27,340	30,700	33,920	37,120	40,400	43,660
Private	19,130	20,960	22,610	24,210	25,800	27,580	29,350
	43,550	48,300	53,310	58,130	62,920	67,980	73,010
Ontario							
Public	500	720	950	1,220	1,500	1,810	2,110
Private	3,570	4,840	6,200	8,070	9,940	12,320	14,710
	4,070	5,560	7,150	9,290	11,440	14,130	16,820
Steuben							
Public	2,000	2,210	2,300	2,350	2,410	2,430	2,450
Private	1,970	2,000	2,000	2,000	2,000	2,000	2,010
	3,970	4,210	4,300	4,350	4,410	4,430	4,460

(continued)

Table J19.--Population Served by Central Water Supply Service Systems and by Individual Private Systems, Genesee River Basin, 1960, and Projections by Decade From 1970 to 2020. (continued)

County and Source	1960	Projections 1970	1980	1990	2000	2010	2020
	Number						
Wyoming							
Public	12,340	13,340	14,390	15,450	16,530	17,360	18,190
Private	7,120	7,350	7,590	7,870	8,150	8,330	8,500
	19,460	20,690	21,980	23,320	24,680	25,690	26,690
PENNSYLVANIA							
Public	0	0	0	0	0	0	0
Private	1,450	3,800	5,720	6,790	7,720	7,250	7,590
	1,450	3,800	5,720	6,790	7,720	7,250	7,590
Basin Total							
Public	60,200	65,550	70,990	76,600	82,320	87,660	92,970
Private	58,590	66,820	73,960	81,840	89,210	96,400	103,970
	118,790	132,370	144,950	158,440	171,530	184,060	196,940

Source: U. S. Public Health Service, New York State Water Resources Commission, Cornell Aeronautics Laboratory

Table J20.--Annual Farm Labor Requirements, Genesee River Basin, Projected by Decades From 1970 to 2020.

Commodity	Projections for:					
	1970	1980	1990	2000	2010	2020
	Thousand hours					
Beef	962	880	855	848	945	994
Lamb	88	76	70	96	90	87
Pork	57	32	39	36	20	27
Milk	7,515	6,060	4,856	5,243	5,412	6,687
Broilers	210	222	238	256	290	308
Chickens	42	37	68	64	58	84
Eggs	194	151	122	113	77	69
Wheat	421	347	322	290	263	289
Dry beans	264	272	271	276	262	208
Potatoes	299	294	255	269	211	211
Vegetables	1,262	1,265	1,219	1,288	1,410	1,525
Fruit	204	168	114	83	58	29
Hay	1,194	1,105	1,016	932	808	799
Corn grain	219	183	171	148	156	122
Corn silage	340	282	263	245	218	253
Oats	525	468	410	405	333	374
Miscellaneous	264	234	216	204	200	188
TOTAL	14,060	12,076	10,505	10,796	10,811	12,254

Projected forest-based industry production and employment

Projected production of lumber, woodpulp, and paperboard in the economic area of the Genesee River Basin is shown in Appendix Table J-A19. Projections of employment in the lumber and wood products industry are presented in Appendix Table J-A20. Appendix Table J-A21 presents projected employment in the pulp and paper manufacturing industry.

The projections indicate that lumber production in the Genesee area is expected to increase by approximately 84 percent from 1960 to 2020.

The Genesee River Basin area presently has four relatively small paper mills and no woodpulp mills. For this reason, projections are less reliable than might be the case for an area with more production. In general, however, the projections follow the expected trends for New York State, consistent with expected trends in resource availability. Based on past trends and announced expansion plans of the pulp and paper industry in the Northeastern Region, all of the projected growth in the Region's woodpulp capacity and production is expected to occur in plants which integrate pulp production with the manufacture of paper, paperboard, or building board. It is not anticipated that non-integrated pulp mills (Standard Industrial Classification - 261) will be established in the Genesee Basin, but because of the small capacity and age of the paper mills in the Basin, some new woodpulp production will probably develop as these mills seek to improve their competitive position by integrating operations. Production of paper and paperboard is expected to increase by almost 300 percent from 1960 to 2020.

Production of secondary paper products is expected to increase at a weighted average annual rate of 3.2 percent over the projection period.

The combined effects of a net increase in total production and an increase in labor productivity are expected to lead to relatively constant employment in the secondary manufacturing segment of the lumber industry from 1960 to 2000, after which a moderate decrease is expected.

A moderate decline in employment in the primary segment of the pulp and paper manufacturing industry is projected from 1960 to 2020, while employment in the secondary segment is expected to increase by about 25 percent over the same period.

LAND NEEDS TO MEET PRODUCT REQUIREMENTS

Demand for Agricultural Products by Land Resource Area

Production trends for agricultural products in the Genesee River Basin were established in the Agricultural Description Section. Projections of agricultural output as a percentage of production in the Middle Atlantic

Region[1] are given in Appendix Tables J-A22 and J-A23. When these percentages are applied to the projected Middle Atlantic production (Appendix Tables J-A24 and J-A25) current and projected output of major farm products are generated.

Agricultural Product Requirements

To determine the number of acres that will be used in producing the projected output, three steps are employed. In step one, output data for livestock production (Appendix Tables J-A24 and J-A25) is multiplied by the feeding efficiencies shown in Table 34, page 64 of the Economic Base Study for Agriculture Report. This gives the total feed unit requirements for livestock (Appendix Table J-A26 and J-A27). In step two, the feed unit requirements are divided into two groups, concentrate feeds and roughage feeds (Appendix Tables J-A28 and J-A29) based on 1959 production. In step three, feed units of the various concentrate and roughage crops are divided by yields per acre to estimate future acreages of forage and grain crops. Output of wheat, vegetables, etc., is divided directly by yields to determine acreage. The acreage requirements are given in Tables J21 and J22.

Trends in land use would indicate that the supply of available land will be adequate to meet product needs.

Forest Product Requirements

Information collected and compiled by the Forest Service concerning the present forest resource and likely timber growth under various levels of timber management in the Basin was analyzed. A comparison of this information with projected timber drain based on projected levels of production for both major industries indicated the following:

1. Overall timber growth at the present time exceeds the current level of cutting.
2. Overall levels of projected timber growth for the major forest types for target years exceed projected levels of cutting for the Basin as a whole.

Thus, projected production of lumber and woodpulp for target years appears to be within the quantities of timber likely to be available for these industries under the assumptions that were made. It is possible, however, that future timber quality and unforeseen changes in forest ownership and land use may modify the projected availability of timber.

1/ The Middle Atlantic States consist of: New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia and West Virginia.

TableJ21.--Acreage requirements, Ontario Plain, Genesee River Basin, 1960, and projected by decades from 1970 to 2020

	1960	Projections 1970	1980	1990	2000	2010	2020
	- - - -	- - - -	- - - -	- - A c r e s	- - - -	- - - -	- - - -
Feed crops							
Corn grain	16,600	13,900	12,900	12,200	11,800	11,200	10,600
Corn silage	19,200	17,500	15,500	14,400	13,800	12,800	12,600
Hay	81,600	72,900	65,400	60,000	58,000	54,200	54,300
Oats	34,700	32,100	29,200	28,100	25,600	24,500	23,100
Cropland pasture	22,700	21,900	21,800	22,400	24,000	26,400	29,200
Subtotal	174,800	158,300	144,800	137,100	133,200	129,100	129,800
Nonfeed crops							
Wheat	42,600	38,200	30,200	27,500	25,200	22,400	20,100
Dry beans	17,700	17,000	17,300	17,700	18,300	19,400	20,900
Potatoes	2,000	1,400	1,100	800	800	700	600
Vegetables	17,400	17,100	17,000	17,000	17,800	17,900	18,600
Fruit	3,200	2,600	2,300	2,200	1,800	1,800	1,600
Subtotal	82,900	76,300	67,900	65,200	63,900	62,200	61,800
Miscellaneous crops	7,700	7,000	6,400	6,200	6,100	6,200	6,000
Total - All cropland	265,400	241,600	219,100	208,500	203,200	197,500	197,600
Permanent pasture	69,400	63,600	62,800	60,300	62,100	62,500	67,300

TableJ22.--Acreage requirements, Allegheny Plateau, Genesee River Basin, 1960, and projected by decades from 1970 to 2020

		Projections					
	1960	1970	1980	1990	2000	2010	2020
	Acres						
Feed crops							
Corn grain	8,920	7,380	5,800	4,600	3,700	3,100	2,600
Corn silage	16,050	14,000	11,300	9,900	8,500	7,400	6,600
Hay	121,870	103,710	89,500	78,700	70,900	61,200	57,400
Oats	41,100	34,700	28,800	23,600	21,900	22,500	17,500
Cropland pasture	19,300	16,000	13,300	11,600	10,300	8,800	7,300
Subtotal	207,300	175,800	148,700	128,400	115,300	103,000	91,400
Nonfeed crops							
Wheat	17,800	16,100	12,800	11,400	10,200	9,600	8,600
Dry beans	5,200	3,000	3,300	2,700	2,100	1,700	1,200
Potatoes	4,200	3,800	3,600	3,300	3,300	3,200	3,100
Vegetables	7,400	6,900	7,200	7,500	7,400	7,700	7,600
Fruit	1,200	700	600	300	300	0	0
Subtotal	35,800	30,500	27,500	25,200	23,300	22,200	20,500
Miscellaneous crops	7,300	6,200	5,300	4,600	4,200	3,800	3,400
Total - All cropland	250,400	212,500	181,500	158,200	142,800	129,000	115,300
Permanent pasture	109,800	109,700	90,000	85,500	88,400	94,200	96,200

WATER NEEDS TO MEET FUTURE BASIN REQUIREMENTS

Flood Control

In the watersheds, 226 structures were examined with respect to their potential for main stem and watershed flood control as well as for other multiple purpose uses. Of these structures, 19 were selected as offering significant preliminary flood control benefits. The preliminary benefits assigned to these structures are shown in Table J23. Their general location within the Basin is shown in Plate J20.

Table J23.--Flood Control Structures and Associated Flood Damage Reduction Benefits in the Watersheds, Genesee River Basin, 1966.

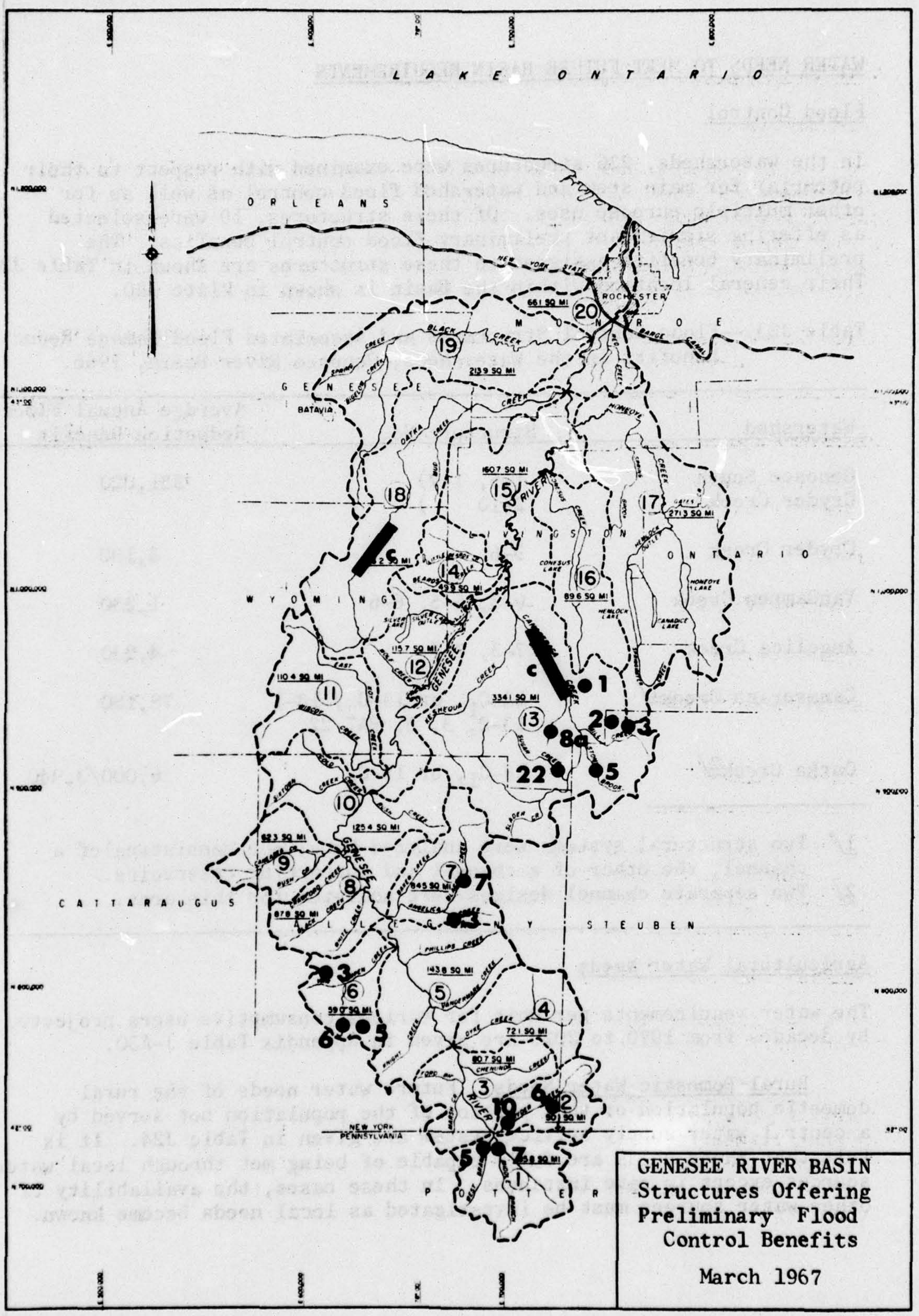
Watershed	Structure No.	Average Annual Flood Reduction Benefit
Genesee South Cryder Creek	1-5, 1-7) 2-10)	$31,020
Cryder Creek	2-6	3,190
VanCampen Creek	6-3, 6-5, 6-6	1,230
Angelica Creek	7-3, 7-7	4,230
Canaseraga Creek 1/	13-C_1, or 13-C_2, 13-1 13-2, 3, 5, 8A, 22	78,180
Oatka Creek 2/	18-C_1, or 18-C_2	6,000/3,940

1/ Two structural systems were analyzed here; one consisting of a channel, the other of a channel and supporting reservoirs.
2/ Two separate channel designs were analyzed for this area.

Agricultural Water Needs

The water requirements per unit for various consumptive users projected by decades from 1970 to 2020 are given in Appendix Table J-A30.

Rural Domestic Water Needs. Future water needs of the rural domestic population or that portion of the population not served by a central water supply service system are given in Table J24. It is felt that these needs are fully capable of being met through local water sources except in rare instances. In these cases, the availability of other water sources must be investigated as local needs become known.



GENESEE RIVER BASIN
Structures Offering
Preliminary Flood
Control Benefits

March 1967

Plate J20

Table J24.--Annual rural domestic water requirements, Genesee River Basin, projected by decade from 1970 to 2020.

County	Projections for 1970	1980	1990	2000	2010	2020
	Millions of gallons					
NEW YORK						
Allegany	266	392	524	628	752	873
Genesee	202	349	533	723	952	1,203
Livingston	352	561	778	979	1,208	1,457
Ontario	81	154	259	377	540	730
Steuben	34	50	64	76	88	100
Wyoming	123	188	253	309	365	422
PENNSYLVANIA						
Potter	64	142	218	293	318	377
Total	1,122	1,836	2,629	3,385	4,223	5,162

Livestock Water Needs. Future livestock water needs for each of the Land Resource Areas are given in Tables J25 and J26. As in rural domestic water needs, it is felt that these needs are generally capable of being met locally.

Irrigation Water Needs. If vegetable crop yields increase in the Basin at the same rate as national yields are expected to increase and the Basin retains its present share of the national market, Table J27 indicates future needs for irrigation water in the Basin by decade. It is expected that in 1970, 20 percent of the potato and vegetable acreage will be irrigated, 50 percent by 1980, and 100 percent by 1990 and thereafter.

Because the acreage figures shown in this table exert considerable pressure on the available irrigable land and because of other rapidly growing needs for land, it is doubtful whether the Basin will maintain its current share of the vegetable and potato market.

Table J25.--Annual water requirements for livestock, Ontario Plain, Genesee River Basin, projected by decade from 1970 to 2020.

	Projections for					
	1970	1980	1990	2000	2010	2020
	Millions of gallons					
Beef and veal	151	171	203	239	284	337
Lamb and mutton	10	10	10	12	12	12
Hogs	17	17	17	17	17	25
Milk cows	445	520	608	753	895	1,122
Chickens	1/	1/	1/	1/	1/	1/
Eggs	6	6	7	9	10	12
Broilers	1/	1/	1/	1/	1/	1/
Total	629	724	845	1,030	1,218	1,508

1/ Less than one million.

Table J26.--Annual water requirements for livestock, Allegheny Plateau, Genesee River Basin, projected by decade from 1970 to 2020.

	1970	1980	1990	2000	2010	2020
		Projections for				
	- - - - - - - Millions of gallons - - - - - - -					
Beef and veal	182	189	203	239	284	302
Lamb and mutton	10	10	10	17	16	16
Hogs	8	0	8	8	0	0
Milk cows	473	491	545	610	692	795
Chickens	1/	1/	1/	1/	1/	1/
Broilers	1/	1/	1/	1/	1/	1/
Eggs	3	3	2	2	0	0
Total	676	693	768	876	992	1,113

1/ Less than one million

Table J27.--Annual requirements for irrigation water by Land Resource Area, Genesee River Basin, projected by decade from 1970 to 2020. 1/

Land Resource Area	1970	1980	1990	2000	2010	2020
		Projections for				
	- - - - - - - Millions of gallons - - - - - - -					
Ontario Plain	1,206	2,965	5,800	6,061	6,061	6,256
Allegheny Plateau	684	1,760	3,519	3,487	3,552	3,487
Total	1,890	4,725	9,319	9,548	9,613	9,743
	- - - - - - Acre Feet and Acres Irrigated - - - - - -					
Ontario Plain	3,700	9,100	17,800	18,000	18,000	19,200
Allegheny Plateau	2,100	5,400	10,800	10,700	10,900	10,700
Total	5,800	14,500	28,600	28,700	28,900	29,900

1/ Irrigation is for potatoes and vegetables including storage and distribution losses. The determination of per-acre irrigation water needs is discussed under "Irrigation Benefit Analyses" later in the report.

There is some evidence that dairy farms in the gravelly valley soils in the Allegheny Plateau in other parts of New York may irrigate forage crops when additional land for expanding the size of farm is unavailable. However, little of the Basin fits this description and no water for irrigation of forage crops has been included. For a description of irrigation in the Basin, see the Agricultural Description section and for problems associated with irrigation, see the section under Present Land and Water Resource Problems and the section on irrigation of the Ontario Lake Plains Service Area at the end of this report.

In determining the potential of the Basin to meet these requirements for irrigation water in the future, consideration was taken of several factors.

First, the areas which could be irrigated were examined. Topographic maps showing the irrigable areas as delineated on Plate J19 (page J81) were checked to determine whether any of the sites listed in the tentative site inventory could supply irrigation water to the area. This determination was based upon the desirability of one or several large contiguous areas within about five miles below the potential structure in order to get an economical distribution system.

Then, the potential benefits to be derived from these sites were determined. This involves an estimate of the acreage to be irrigated and the per-acre benefits from irrigation. A more complete discussion of the procedure is given later in the report under "Irrigation Benefit Analysis." It was assumed that in an area capable of being irrigated and desirous of irrigation water, no more than thirty percent of the land would be under irrigation at any time. Benefits were then calculated for this thirty percent. Benefits stem from the increased yield due to irrigation, net of the on-farm irrigation costs. In general, these benefits ranged from $30 to $35 depending on the type of vegetables expected to be grown. The vegetable crop mix was determined through census reports and local preference for particular crops.

Finally, annual costs for the irrigation structure were determined from the total of amortized installation costs plus operation and maintenance costs. Average annual benefits were compared with average annual costs over a one hundred-year evaluation period in order to determine a benefit-cost ratio. Systems having a benefit-cost ratio of 0.75 to 1.00 or greater were accepted for inclusion in the report in order to account for possible errors in assumption regarding percent acreages to be irrigated, crop mix, etc.

Preliminary project formulation was limited in the Basin to only three watershed areas proposed to meet irrigation needs in the next 15 years. Their locations are shown on Plates J21, J22, and J23. These watershed areas are detailed in the following section on structural plans and will irrigate between 1,100 and 2,300 acres of cropland, depending upon the combination of structures chosen.

Due to the fact that a large portion of the irrigable land is not located below potentially feasible sites, this plan provides irrigation water for only eleven to twenty-three percent of the land expected to be irrigated. Any additional desired water supplies will need to be developed from surface flows, ground water sources, and from local one or two-farm impoundments. The availability of these alternative sources was not determined in this study, but it is likely that considerable opportunity exists for such development.

Orchard Spray Needs. Water needs for orchard spraying is given in Table J28. It should be noted that this need comprises less than one percent of total agricultural water needs and varies considerably from farm to farm. No attempts were made to develop any group projects to supply this water for those reasons and landowners should make attempts to obtain this water from local sources. It is not anticipated that there should be any difficulty meeting this need.

Table J28.--Projected Requirements for Orchard Spray Water by Decade, Genesee River Basin, 1970-2020

Year	Water Requirements (Million Gallons)
1970	14
1980	11
1990	10
2000	8
2010	7
2020	7

Forest-based Industrial Water Needs

The quantity of water required for pulp and paper production varies with the type of pulp consumed. Water requirements also vary according to whether market pulp is purchased, or if the paper plant is integrated with pulp producing facilities. Water requirements for paperboard mills are also variable. The variability of these requirements can be seen in Table J29 which gives water requirements for different operations in the paper making process by pulping techniques. With reference to this table, it can be seen that even for a given pulping process, water requirements can vary significantly. It is not possible to be specific regarding pulping techniques since most grades of paper and board can be manufactured from a variety of pulp mixtures and other fibrous materials. Consequently, projections of potential use of various types of pulp necessarily have a much larger measure of uncertainty than projections of all grades of pulp and/or paper combined. However, it appears reasonable to conclude that expansion of pulping in the Middle

Atlantic region will be concentrated most heavily in the hardboard, neutral sulfite semi-chemical, and sulfate processes. The groundwood and sulfite processes are generally employed in regions where a larger softwood resource is available as in Northern New England and in the Southeast.

It should also be cautioned that the water requirement figures presented in Table J29 are based on data published in 1957 and will not necessarily hold through time. It is highly probable that water requirements for each of the pulping processes will decrease somewhat in the future.

Table J29.--Water Quantity Requirements for Elemental Pulp Processes, 1957

Operation	Pulping Techniques				
	Groundwood	Hardboard	NSSC 1/	Sulfate	Sulfite
	(Thousand gallons per ton of pulp produced)				
Debarking	Varies from 0-7.5 thousand gallons depending on pulping techniques, process and equipment employed				
Pulp mill	1	-	3-20	20	30
Bleaching	1				
Partial	-	-	20	20	
Full	-	-	40	40	40
Dissolving pulp	-	-	-	50-100	50-100
Paper mill	7-10	5-20	10-25 2/	10	10

1/ Neutral Sulfite semi-chemical technique

2/ Ranges in neutral sulfite semi-chemical for pulping and paper arise because of variations in washing techniques. Where three thousand gallons are used in the pulp mill 25 thousand are used in the paper mill. When pulp is washed before going to the paper mill, 20 thousand gallons are used in the pulp mill and 10 thousand in the paper mill.

Source: Water treatment and disposal aspects to development of California's pulp and paper resource. State Water Pollution Control Board, Publication No. 17, 1957, Sacramento, California

However, from the data previously presented for projected production in the pulp and paper industry a possible additional annual water requirement of from $1\frac{1}{2}$ to 4 billion gallons for woodpulp production by 1980, and from $3\frac{1}{2}$ to 9 billion gallons by 2020 can be anticipated. In addition, it can be anticipated that present paper mill requirements might double by 1980 and almost triple by 2020.

It is not known whether these water needs are capable of being met within the Basin until reports indicating other needs and sources of impounded water are received from other cooperating Task Groups.

Other Basin Water Needs

Water Quality Control. Water quality control has become a great concern for the rural and the urban sections of the Basin due to the increase of many types of modern day contributors to water contamination.

While being unable to correlate present use of fertilizer and pesticides with the magnitude of stream pollution, some generalizations can be made about the nature of this problem in the future.

1. To meet future needs for food, agricultural production is expected to be three times larger than present production.

2. Considerable cropland will be lost from production because of (a) urban uses for housing, highways, schools, etc., (b) inability of some soils to sustain profitable levels of production, and (c) needs for recreational land.

3. The land remaining in production will of necessity be required to have higher yields per acre.

4. Along with other kinds of new technology, an increased use of fertilizer and pesticides per acre will be needed to produce these higher yields.

5. While the total amount of fertilizer and pesticides used in the Basin may not change greatly, the concentrated use on a smaller acreage could lead to an increase in stream pollution in local areas. This pollution would result from higher percolation losses resulting from the expected increased use of fertilizer and from greater exposure of unprotected soil. Higher losses due to erosion are also likely from the more intensive use of the remaining cropland without more intensive management practices. Waste materials and erosional debris from these and from municipal and industrial sources are degrading water quality. Therefore, there is a great need for water quality facilities and controls to assure water of suitable quality for all reasonable water uses.

Cooperating agencies of Task Group No. 4, Water Supply and Water Quality Control, determined the quality of surface and ground waters and character of waste-water discharges to evaluate impact upon water quality and potential need for low flow augmentation and treatment. A complete description of water quality studies, stream flow requirements and critical reaches needing low flow augmentation may be found in the report prepared by Task Group No. 4.

Preliminary stream flow requirements were determined by Task Group No. 4 for ten critical reaches in the Genesee River Basin. These flows were based upon the assumption that waste loads will receive secondary treatment and they represent the estimated flows required for the present, the year 1980 and the year 2020.

Twenty-six critical reaches were determined in the Genesee Basin; five of which are on the Genesee River while the remaining ones are on tributary streams. The U.S. Department of Agriculture has selected upstream watershed sites to supply low flow requirements at four of these critical reaches for the capacities required to year 2020. These sites and the problem areas which they serve are listed later in the report under Program for Immediate Needs.

Municipal and Industrial Water Supply. At present, water for municipal and industrial supply is obtained generally from local streams, wells or Lakes for the rural area needs and from deep wells or large lakes for the urban areas. Some water systems in the Basin are being used to the full capacity of present sources of supply and new supplies will be needed for expected future demands. Monroe County is basically supplied with water from Lake Ontario while the city of Rochester derives much of its water supply from Hemlock Lake.

The ground water sources of the Genesee River Basin vary significantly by physiographic reaches and in most of the Basin are far from adequate to meet the water demand.

Coordinating agencies of Task Group No. 4 have performed the task of:

1. Estimating future municipal and industrial water demands based on population projections made in the economic study.

2. Appraising existing sources for their ability to provide for future requirements.

3. Determining the municipal and industrial water supply needs by decade up to the year 2020.

Preliminary needs were furnished by Task Group No. 4 in order that possible upstream watershed reservoirs could be selected as a potential supply for municipal and industrial water. These needs were indicated separately for counties, towns and villages and were expressed in millions of gallons per day. Monroe County was excluded due to its adequate supply from Lake Ontario.

The Department of Agriculture has used these preliminary estimates of water supply demands and has selected the upstream watershed reservoirs shown in the structural program section.

Ground water availability in the Basin was also determined by the coordinating agencies of Task Group No. 4 and appears in Appendix "I". Consideration of water availability from this source was taken during plan formulation for water supply structures.

<u>Fish and Wildlife</u>. The fish and wildlife resource of the Basin is closely integrated with the agricultural resource since both occupy, to a large extent, the same lands. In recent years large areas of the Basin have reverted from active farmland to brushy and wooded areas. This reverted land is well serviced by a road network and has given the sportsman more opportunity to hunt than is generally available in many other regions of the United States.

According to a preliminary report by Task Group 9, the quality of the waterfowl resource has declined and the trout lake and stream fishing is no more than adequate at present. The expanding population in the northern part of the Basin will place ever-increasing demands upon the remaining resources and attempts should be made to provide for these increasing demands. A more thorough statement of the problems facing these resources can be seen in Appendix "N", Fish and Wildlife Studies.

In the early phases of the comprehensive Basin study, the tentative upland site inventory was transmitted to Task Group 9 for the determination of those reservoirs which could enhance the fish and wildlife resources of the Basin. The list was narrowed down into those sites which could offer significant fish and wildlife benefits as a primary single purpose, and those sites which could offer significant fish and wildlife benefits incidental to some other compatible purpose.

The sites composing the above list were designed and costs estimated as part of the Task Group 5 study and entered into the unilateral project formulation phase of this group. The sites were appraised according to benefit criteria given by Task Group 9. These benefits were based upon expected user-days and benefits per user-day.

The list of sites with appropriate engineering and economic data follows under Program for Immediate Needs.

Recreation. A pattern of ever-increasing demand for recreational facilities has been experienced in all areas of the country. The Genesee River Basin and its zone of influence with its rapidly growing urban areas is no different. Increases in population, income, and leisure time and the greater mobility of the people have already crowded many of the present facilities and reinforce the need for planning for the future.

The determination of those sites which could offer recreational potential was made in cooperation with Task Group 8. These sites were designed and costs estimated in conjunction with other Task Group 5 sites.

Recreation use, costs, and benefits for each site were offered by Task Group 8. Benefit-cost ratios were then computed for each site. In most cases, these sites will offer incidental fish and wildlife benefits although it is an additional primary purpose for several of the sites.

In total, 13 upstream sites were found to be feasible for recreational development. Some of these are located quite close to the urban areas of Rochester and should be recommended for immediate acquisition and construction. All of them should be considered in any plan for Basin development in the next 15 years. A list of the sites and their location is shown following under Program for Immediate Needs.

Due to the presence in the Basin of several large lakes, access to Lake Ontario, two state park facilities, a number of smaller parks and the potential facilities examined here, it is likely that the Basin will come closer to satisfying its recreation demands than many other regions in the country.

LAND USE BY MAJOR TYPES

Cropland projections appear in Table J30. The projections are based on an economic appraisal of farms done by the Agricultural Economics Department at Cornell University. A complete explanation of the procedure appears in the attachment, The Agricultural Economy of the Genesee River Basin, pages 40 to 45. Pasture acreage is expected to decline at about the same rate as cropland. However, it is expected that beef enterprises in the Allegheny Plateau will utilize somewhat larger acreages of pasture than the farms in the Ontario Plain. Pasture acreage projections are given in Table J31. Projections of forest land

Table J30.--Projections of Cropland Acreages by Decade, Genesee River Basin 1970 to 2020

County	1970	Projections 1980	1990	2000	2010	2020
	----------------	Thousand Acres	----------------			
Allegany	92	63	46	35	27	22
Cattaraugus	1	*	*	*	*	*
Genesee	63	60	56	55	54	52
Livingston	195	175	163	156	147	139
Monroe	54	46	39	33	26	18
Ontario	25	24	22	21	20	19
Orleans	*	*	*	*	*	*
Steuben	22	20	18	17	16	15
Wyoming	90	83	77	75	71	67
Potter, Pa.	12	11	10	8	7	5
Total	554	482	430	399	368	337

* Less than 1000 acres

Table J31.--Projections of Pasture Acreage by Decade, Genesee River Basin 1970 to 2020.

County	Projections					
	1970	1980	1990	2000	2010	2020
	Thousand Acres					
Allegany	75	70	65	61	56	50
Cattaraugus	1	1	1	1	1	1
Genesee	23	23	24	24	25	25
Livingston	68	65	63	61	59	56
Monroe	9	7	5	4	2	*
Ontario	14	15	16	17	17	18
Orleans	*	*	*	*	*	*
Steuben	7	7	7	6	6	5
Wyoming	26	25	24	23	23	22
Potter, Pa.	9	8	6	5	4	3
Total	231	221	211	201	192	181

* Less than 1000 acres

are given in Table J32. By making a comparison between topographic quadrangles and air photos, the Agricultural Economics Department at Cornell has estimated an increase in forest land acreage of between 17 and 29 percent for Allegheny Plateau counties by 1990.1/ Projections for the Genesee River Basin show an increase of 20 percent. Projections of urban land use appear in Table J33. Note, almost all the land in Monroe County will be in urban uses by 2020. Projections of other land use are given in Table 34. Other land includes all land not classified as cropland, pasture, forest land or urban.2/ Other land also includes idle land which includes crop and pasture land no longer used for farming but has not enough tree cover to class as forest land.

Land Treatment Needs

It is apparent that the land resources of the Basin will have to be managed more intensively if they are to maintain their productive capacities. More and more pressure, as noted in Table J30, Projections of Cropland Acreage, will be placed on segments of this resource. These pressures involve all of the managerial aspects from technology to proper use and appreciation of good conservation measures. To this end, the proper use and management of these resources must be recognized as the first increment of any comprehensive plan dealing with the Basin's water and related land resources.

Land treatment measures to reduce erosion, eliminate excessive water conditions, improve unfavorable soil condition and protect forest lands need to be installed. Acreages of land requiring these conservation measures were analyzed from a number of aspects. These included acreages of land which have already been satisfactorily treated as well as the areas not feasible to treat either from economical or physical standpoints. Analysis of this type data then presents an appraisal of the total job to be accomplished.

Any plan for the application of conservation measures must recognize the total job required to meet the needs. In this respect estimates are made and presented in the formulation section of this report which recognize the overall magnitude of the job.

1/ Unpublished data.

2/ Definition of land use appears in New York State Soil and Water Conservation Needs Inventory 1962.

Table J32.--Projections of Forestland Acreage by Decade, Genesee River Basin, 1970 to 2020

County	1970	Projections 1980	1990	2000	2010	2020
	----------------	----------------	Thousand Acres	----------------	----------------	----------------
Allegany	198	210	217	223	229	236
Cattaraugus	6	6	6	6	6	6
Genesee	21	21	21	21	21	21
Livingston	85	96	100	106	111	116
Monroe	15	14	12	11	9	8
Ontario	31	33	34	35	36	37
Orleans	*	*	*	*	*	*
Steuben	19	21	22	23	24	25
Wyoming	57	63	66	69	72	75
Potter, Pa.	30	32	33	34	35	36
Total	462	496	511	527	543	559

* Less than 1000 acres

Table J33.--Projections of Land in Urban Use by Decade, Genesee River Basin, 1970 to 2020.

County	1970	1980	1990	2000	2010	2020
	Projections					
	---Thousand Acres---					
Allegany	13	13	14	14	14	14
Cattaraugus	*	*	*	*	*	*
Genesee	7	8	9	10	11	12
Livingston	9	10	11	13	14	15
Monroe	54	64	76	93	111	125
Ontario	5	5	6	6	7	8
Orleans	*	*	*	*	*	*
Steuben	*	*	*	*	*	*
Wyoming	6	6	6	7	7	7
Potter, Pa.	*	*	*	*	*	*
Total	95	106	122	143	165	182

* Less than 1000 acres

Table J34.--Projections of Other Land Use 1/ by Decade, Genesee River Basin, 1970 to 2020

County	Projections					
	1970	1980	1990	2000	2010	2020
	Thousand Acres					
Allegany	113	135	149	158	165	169
Cattaraugus	1	2	2	2	2	2
Genesee	15	17	19	19	18	19
Livingston	35	46	55	56	61	66
Monroe	27	28	27	18	11	8
Ontario	10	8	7	6	5	3
Orleans	2	2	2	2	2	2
Steuben	7	7	8	9	9	10
Wyoming	13	15	19	18	19	21
Potter, Pa.	10	10	12	14	15	17
Total 2/	233	270	301	305	307	316

1/ Other Land Use is the residual after other projections are deducted from the total land area less water area. No additional acreage of water was projected. Other land includes idle land and recreation land.

2/ Totals may not be additive due to rounding error.

FORMULATION OF A PLAN
FOR
THE GENESEE RIVER BASIN

NEEDS FOR CONSERVATION TREATMENT

Land treatment measures are needed and will be applied in all parts of the Basin. They are especially necessary above any of the proposed structural measures and will be included in any structural program. The measures will include those required to reduce soil erosion, alleviate excess water and improve unfavorable soil conditions on cropland. Measures to be included on pasture lands include the establishment and improvement of cover conditions and protection from overgrazing, erosion and excess water. Forest land measures will include establishment of timber stands, improvement of hydrologic conditions, erosion control features as well as protection of some woodlands from overgrazing.

Erosion control features on cropland will include contour cultivation and strip cropping on slopes up to 250 to 300 feet in length. Grass waterways will be established in depressions and draws. Diversion terraces with strip cropping between the diversions will provide protection on slopes more than 300 feet in length. Rotations, which include a high percentage of sod forming or close growing crops will be utilized where needed.

Excess water on croplands will be alleviated by the application of such practices as surface field ditches and diversion terraces, and installation of tiles. Those lands having unfavorable soil conditions will be managed, protected and improved in about the same manner as lands having erosion problems.

Establishment and improvement of vegetative cover will be utilized on those lands converted to pasture or on present pasture areas in poor condition. Liming, fertilizing, mowing, and controlled grazing are the most important and widely used pasture improvement measures to be employed.

Table J35 provides a summary of total needed land treatment measures and the estimated costs of that treatment. The costs are based upon weighted average costs of the typical treatment measures needed to correct the deficiencies.

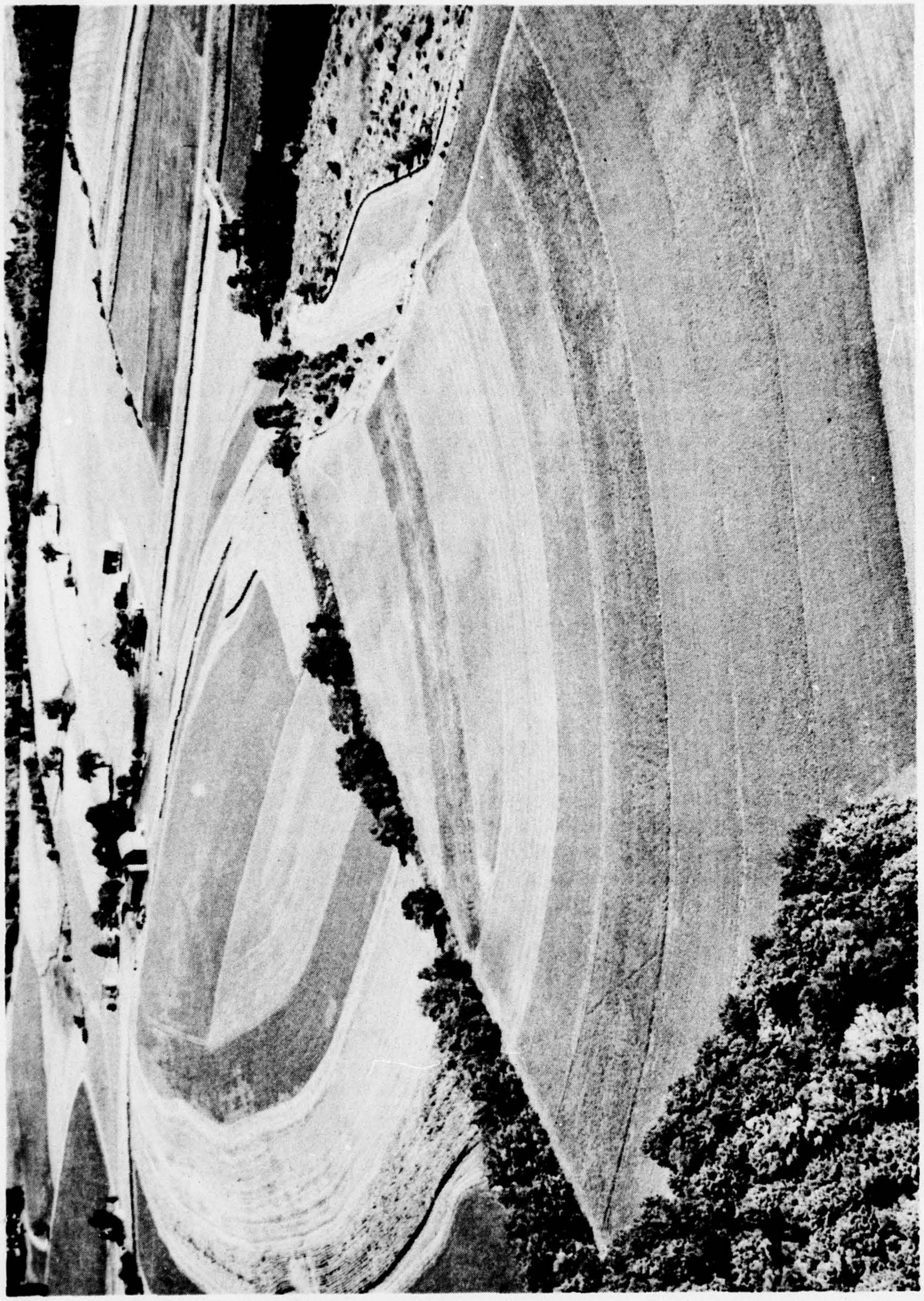


Photo J10-Well managed farmland in Wyoming County

Table J35--Needs and Cost Summary for Conservation Treatment, Total Program and Program to 1980, Genesee River Basin, 1967.

Land Use	Total Program: Acres Needing Treatment	Total Program: Estimated Cost	Program to 1980: Acres to be Treated	Program to 1980: Estimated Cost
Cropland	312,000	$20,053,000	111,000	$7,126,000
Pasture	154,000	10,117,000	42,000	2,755,000
Forest Land	271,000	11,000,000	74,500	3,030,000
Total	737,000	$41,170,000	227,500	$12,911,000

A more detailed description of the amount of various classes of measures needed by county in the Basin follows in Tables J36, J37, and J38.

Crop and Pasture Land

Conservation treatment will be necessary on 312,000 acres of cropland in the Basin, (See Table J36). Erosion is the dominant problem on 218,000 acres and will require contouring, strip cropping, diversions, and grassed waterways to reduce the hazard. Tile drains and open ditches will be necessary to reduce the amount of excess water which is a problem on 90,000 acres of the Basin. Unfavorable soils which yield poor crops are a problem on 4,000 acres. This land should be converted to pasture or woodland for maximum efficiency.

Pasture treatment is required on 154,000 acres in the Basin, (See Table J37). Establishment and improvement of cover through planting, mowing and fertilizing is needed on 120,000 acres while better land management to prevent overgrazing should be practiced on 7,000 acres of the pasture land. Cover protection from erosion and excess water through diversions, tile drains, and open ditches is necessary on 27,000 acres of the land.

Forest Land

Forest land treatment is required on 271,000 acres in the Basin, (See Table J38). Establishment of forest cover through planting and exclusion of cattle from fields that are reverting to forest naturally is needed on 96,500 acres while 27,000 acres of forest land should be fenced to prevent grazing. Hydrologic cultural improvements, including thinning, weeding, sanitation cutting and marking of timber stands for harvesting to prevent over-cutting, are needed on 145,000 acres. Erosion control work is required on 2,700 acres. This work includes draining and stabilizing old logging roads and trails and oil lease roads and reinforcement planting in poorly stocked stands where sheet and gully erosion is occurring.

Table J36—Land Treatment Needs on Cropland, Genesee River Basin - 1966

County	Total Acres of Cropland	Treatment Needed for Protection From: Erosion	Excess Water	Unfavorable Soils	Total Acres Needing Treat.
Allegany	124,610	36,140	15,290	170	51,600
Cattaraugus	1,600	170	780	0	950
Genesee	64,810	19,460	17,360	140	36,960
Livingston	213,310	60,980	26,830	2,540	90,350
Monroe	61,810	22,960	16,440	1,360	40,760
Ontario	26,400	12,570	1,290	30	13,890
Orleans	600	120	180	0	300
Steuben	24,780	17,260	2,020	0	19,280
Wyoming	96,200	44,320	7,120	0	51,440
Potter, Pa.	13,000	4,440	2,410	100	6,950
BASIN TOTALS	627,120	218,420	89,720	4,340	312,480

Table J37--Land Treatment Needs on Pasture, Genesee River Basin - 1966

County	Total Area Pasture	Est. & Improv. Of Cover	Protection of Cover From: Over-Grazing	Erosion & Excess Water	Total Acres Needing Treat.
Allegany	79,300	26,810	1,070	8,580	36,460
Cattaraugus	1,000	770	150	180	1,100
Genesee	22,300	4,340	1,110	2,900	8,350
Livingston	69,800	55,390	1,370	3,440	60,200
Monroe	10,200	4,180	1,590	3,820	9,590
Ontario	13,800	11,780	370	4,050	16,200
Orleans	250	40	--	--	40
Steuben	7,200	2,330	240	240	2,810
Wyoming	26,570	9,840	1,000	1,340	12,180
Potter, Pa.	9,400	4,450	260	2,280	6,990
BASIN TOTALS	239,820	119,930	7,160	26,830	153,920

Table J38--Land Treatment Needs on Forest Land, Genesee River Basin, 1966

County	Total Acres of Forest Land	Treatment Needed: Establishment of Timber Stands	Hydrologic Improvement	Protection From Grazing	Erosion Control	Total Acres Needing Treatment
Allegany	185,000	54,700	76,000	8,400	1,800	140,900
Cattaraugus	5,820	1,100	2,300	500	--	3,900
Genesee	21,380	800	8,400	200	300	9,700
Livingston	75,180	15,400	18,300	11,400	--	45,100
Monroe	15,800	5,300	3,100	200	300	8,900
Ontario	29,710	4,300	8,000	2,300	100	14,700
Orleans	370	--	--	--	--	--
Steuben	16,530	4,500	6,300	2,400	100	13,300
Wyoming	50,300	9,200	14,300	1,400	100	25,000
Potter, Pa.	27,500	1,200	8,000	100	--	9,300
BASIN TOTALS	427,590	96,500	144,700	26,900	2,700	270,800

Source: Adapted from Conservation Needs Inventory

Table J39 shows the present level of accomplishments under current programs and also presents a program to meet 1980 needs. The cost of this program is estimated at $985,000 for technical assistance and $2,045,000 for installation costs; a total of $3,030,000.

To help implement the program it is recommended that cost-sharing for technical assistance be 80 percent Federal, 20 percent State and that installation costs be 80 percent Federal and 20 percent private. This may require additional Federal legislation and new cooperative agreements between the States and the Federal Government.

The program will reduce erosion and sediment production, thereby improving water quality. It will also improve the hydrologic condition of the treated areas, increasing the ability of those areas to infiltrate and detain storm runoff.

In general, present levels of fire protection are adequate but they should be continued in the future.

Table J 39 - Current and Recommended Program For Forest Land Treatment Measures Genesee River Basin, 1966

Practice	Annual Accomplishments Under Current Programs	Recommended Total Program to 1980	Acceleration Above Current Programs
Management Plans	60 plans	1,650 plans	870 plans
Tree Planting	1,800 acres	35,500 acres	12,100 acres
Hydrologic Stand Improvement	1,100 acres	23,000 acres	8,700 acres
Woodland Grazing Control	500 acres	15,000 acres	8,500 acres
(Fencing)	2 miles	60 miles	34 miles
Erosion Control - Skid Trail and Logging Road	40 acres	1,000 acres	480 acres
	1 mile	25 miles	12 miles

The hardwood stands of the Basin are subject to damage from various defoliating insects but as yet not to any serious degree. A serious problem could arise if the conifer plantations in the Basin became infected with <u>Fomes annosus</u> (a root rot). Practical preventative measures are available and are being used.

POTENTIAL STRUCTURAL PROGRAM

The major objective in formulating a structural program is to provide measures which will come as close as possible to meeting the water and related land resource needs of the Basin. Because these needs change with time, the plan is divided into two essential sections. The first section deals with those structures which should be installed prior to the year 1980 and which will meet current and rapidly developing needs. The second section shows the structures having no current need, but having the potential to serve one or more purposes. As new needs develop and the knowledge of prior needs increases with time, these structures should be reevaluated to determine their potential for meeting the future water resource needs of the Basin.

The formulation of a structural plan was based on first, a study of potential structure site locations and second, selecting those structures which appeared feasible to meet the expressed needs. The needs and subsequent benefits were developed by Task Group Nos. 4, 8 and 9, representing water quality and water supply, recreation, and fish and wildlife respectively. Task Group No. 5 determined the needs for irrigation and flood control in the upstream areas.

When needs and alternative solutions were developed, coordination between the various agencies and task groups determined the best use or combination of uses for each structure. The list of sites recommended for construction represents this coordinated effort and consists of those sites which will either meet the projected needs or come as close as is possible with upstream impoundment structures.

Project formulation on the Ontario Lake Plain included only the purpose of irrigation. Therefore, this plan does not imply that there are no other needs or feasible structures within that area. Several structural possibilities are shown later in the report on Plate J27, which did not have a great deal of irrigation potential and were not included in the plan. These sites should be given consideration by individuals or organizations interested in additional water resource development.

Procedures

Maps. The Genesee River Basin was divided into twenty watershed areas which are designated 1 through 20. Base maps of the entire Genesee River Basin and each watershed were prepared from U.S. Geological Survey topographic maps to show the watershed boundary, drainage pattern, system of roads and other pertinent data. These maps are used to show site locations.

Site Selection. Tentative locations were selected for 226 structures by a study of U.S. Geological Survey topographic maps and a field reconnaissance was made on each site. A final list of 95 sites was established for which design and cost data was developed. Detailed design and cost information for each site may be found in the attachment, "Upland Reservoir Studies." Site screening and the resulting elimination of sites from further study was based on many factors. The factors included: potential needs, stage-storage-surface area relationship, required flood storage, topographic and geologic conditions, and apparent cost of land, roads, buildings and utilities.

Surveys. Centerline profiles were run on structures which appeared to be the most promising. Valley cross-sections were run to determine storm effects and channel capacities at critical areas and below dam sites. Stage-storage surveys were made on various sites to determine the accuracy of the U.S. Geological Survey topographic maps for developing stage-storage information. These surveys proved the need for correcting some of the storage and surface area values derived from 1:62,500 scale topographic maps.

Design Criteria. All designs were based on Soil Conservation Service criteria. All structures were classified according to the hazard regarding existing and future developments downstream from the proposed site.

The designed height of the dams, and the size of the pools were affected by one or many of the following factors: (1) The storage volume needed to retard a 100-year frequency storm without discharge occurring in the emergency spillway, (2) The volume required to contain the emergency spillway and freeboard hydrographs, (3) The selected beneficial storage volume, (4) The additional storage needed for 100-year sediment accumulation, (5) Limiting topographic or geologic features, (6) Allowable downstream release rates, and (7) Critical elevations of existing facilities in the pool area. Embankment volumes were computed using surveyed centerlines or using centerlines plotted from U.S. Geological Survey topographic maps.

Geology Investigations. The intensity of geologic investigation depended upon the physical characteristics of the site area, the potential use of the site, and the significance of geology upon the probable feasibility. Field work when considered necessary, followed map reviews of topographic and soils maps. Surface observation, shallow test holes, hand auger holes, local well records or information, and electric resistivity measurements were conducted.

Erosion and sediment studies were carried out to determine the amount of sediment accumulation expected over a 100-year period. Factors taken into account were: expected land use, sheet and gully erosion, and streambank erosion.

Cost. Construction cost estimates were developed for all reservoirs on the basis of compacted fill using a unit price per cubic yard. This unit price represents all normal construction items except clearing and seeding. The unit price is based on a comparative study of actual contract cost of structures which were installed in the northeast United States under the Public Law 566, Watershed Protection Program.

Clearing and seeding costs were based on dam and permanent pool size and the respective wooded area involved. Where unfavorable geologic conditions exist, a cost of treating the condition is estimated. All total installation costs include construction cost plus 20 percent contingencies, 34 percent installation services, easements, acquisitions, relocations and 1 percent for administration of contracts. Costs of easements, acquisitions, and relocations were estimated by Soil Conservation Service technicians and were based on values obtained from several sources, including local representatives of utilities and highways.

Program for Current Needs

The structures proposed here are intended to meet the water resource needs of the Basin to the year 1980.

Flood Prevention. Various structural measures were investigated to alleviate flooding conditions at noted damage areas. These structural measures included both flood retarding reservoirs and channel improvement where appropriate.

In Watershed No. 2, site 2-6 was found to alleviate the majority of flooding on Cryder Creek. However, the estimated average annual benefit from this

source was determined to be only $3,190, while the average annual cost of site 2-6 was more than ten times as high, or $39,000. As no additional benefits or uses for this site were found, no recommendations for project action are made.

Also in Watershed #2, site 2-10 was analyzed as part of a system of mainstem Genesee River flood control. This system included sites 1-5 and 1-7 and will generate annual costs of at least $202,200. This compares quite unfavorably with the estimated average annual flood prevention benefits of $31,020.

Although each site in the system shows no potential as a single purpose flood control structure, one of the sites, 1-5, has been recommended for construction as a recreation lake. Due to exceptionally high construction costs, the site is only marginally feasible with recreation and flood control benefits. It is felt that the estimated recreation costs are subject to adjustment and with indirect and redevelopment benefits, the site could likely be justified. The benefit-cost analysis is shown in Table J42.

Flood damages in the village of Friendship were estimated at $1,230 annually. A system of flood control structures which would alleviate the major portion of these damages includes sites 6-3, 6-5, and 6-6. Since the average annual cost of this system totals about $42,900, no further recommendations were made for flood control in this watershed. In addition, none of these structures were found to be desirable for other water uses.

Two sites in Watershed #7 were found to offer significant flood reduction benefits along Angelica Creek in and near the village of Angelica. The estimated damage reduction benefits including agricultural, residential, roads, bridges, channels, utilities and indirect are $5,206. The average annual cost of this reduction by sites 7-3 and 7-7 is $57,300, resulting in a benefit-cost ratio of 0.09 to 1.0. Although another site in the watershed, 7-2, is very desirable as a combination recreation- fish and wildlife structure, it offers no flood control benefits and no such need has been shown for sites 7-3 and 7-7 for these or other purposes.

Flooding of the village of Bliss in Watershed #11 causes average annual flooding of less than $1,000. There are no potential structures which could control this flooding and thus no structural programs can be recommended. It is thought that periodic cleaning of the channel beneath bridges in the town would alleviate the major portion of the damages.

Considerably greater opportunity for a flood control program exists in the Canaseraga Creek Watershed. Three separate systems of control were examined in this area. One system, consisting of a flood control channel alone will provide estimated average annual benefits from all sources of $215,920.

The average annual cost of this channel is estimated to be $405,430. A second system consisting of a smaller channel and six upland flood water retarding structures would provide the same level of protection at a cost of $399,370.

The benefit-cost ratio of the first system is 0.53 to 1.0 while the second system has a benefit-cost ratio of 0.54 to 1.0. A third system consisting of a channel and multiple purpose retarding structures on the flood plain has been proposed by the U.S. Army Corps of Engineers as a coordinated effort between the Soil Conservation Service, the U.S. Fish and Wildlife Service, and the Corps of Engineers. The plan is shown in the main report of the Genesee River Basin Comprehensive Study and details will appear in Appendix C - Project Design and Cost Estimates. A watershed investigation report on this area will be made available by the Soil Conservation Service.

Estimated average annual benefits of about $14,500 would accrue to flood control measures in Watershed #18 below the village of Warsaw. Channel improvement was investigated as a possible solution to the problem; however, average annual costs of these measures were greatly in excess of the benefits. There was no possibility of utilizing flood water retarding structures to accomplish the same results due to the large drainage area above the flood plain and the lack of suitable storage sites.

Although flood damages in Watershed #19 occur in both agricultural and urban areas, no determination of the monetary value of these damages was made by the Task Group 5.

Hydrologic analysis of the main stem of the Genesee indicates that the peak elevation of the "5-year" frequency storm was at or above most of the recorded high water marks within the watershed. This indicates that the problem is one of no outlet to Black Creek during periods of flooding on the Genesee. Because of the vast amount of uncontrolled drainage both on the Genesee and on Black Creek above this reach, there is no practicable solution to be found within the watershed.

Because this watershed lies very close to the rapidly urbanizing areas of Rochester and because the flood plain soils offer inexpensive residential construction sites, every effort should be made to restrict the use of these areas to the less intensive uses. Present action on flood plain zoning will save many future tax dollars in attempting to solve an expensive problem.

<u>Irrigation</u>. A total of five sites in three watershed areas appear feasible to provide water for irrigation in the Genesee River Basin. Two of these sites can be excluded since they duplicate areas irrigated from the other sites. The beneficial storage provided by each site is proportional to the number of acres available to irrigate from that particular structure. Multi-purpose use of an irrigation reservoir is limited due to the wide fluctuation of the water level. This fluctuation is not conducive to such uses as recreation or fish and wildlife habitat. However, such sites could be constructed to provide additional storage for other water supply needs.

Only three watersheds were involved in the final determination of feasible irrigation structures in the Basin. In all of them, one site was sufficient to supply irrigation water to the majority of the irrigable acreage although alternative sites were available in each. Similarly, each site offered considerable low-cost extra storage beyond that necessary for irrigation.

These watersheds which offer irrigation water storage present opportunities for development under the Watershed Protection and Flood Prevention Act, Public Law 566. If sponsored by local qualified groups as PL-566 projects, they will need to be evaluated on their individual merits. Discussed below are those watersheds that show opportunities for development. Investigation Reports for each of these watersheds will be made available by the Soil Conservation Service, Syracuse, New York to local interests for their review and information.

Landowners in the Wiscoy Creek Watershed, No. 11 have recently begun to irrigate large areas of potatoes. The portion of the water obtained from Wiscoy Creek has endangered the quality of the fishing resource and construction of site 11-2 could do much to both protect the trout habitat and to supply irrigation water. Cold water release of the excess storage would significantly increase the value of the stream for trout. The detailed location of the site and the irrigable land is shown on Plate J21.

In Watershed No. 17 there are substantial acreages of land suitable for irrigation for which water at a feasible price can be supplied from either of two separate sites. Because of the fact that site 17-19 will supply sufficient water to irrigate a larger number of acres at a lower cost than site 17-21, it is recommended for initial consideration in project formulation. Should problems arise in the utilization of this site, consideration could then be given to site 17-21 as an alternative (See Plate J22).

Landowners in Watershed No. 19 have already attempted to develop interest in a group action plan for meeting irrigation water needs. Although considerable quantities of the potentially irrigable land do not lie adjacent to the stream course, two alternate sites, 19-4 and 19-7, were found to be capable of feasibly irrigating a portion of the land. For reasons similar to those given above, site 19-4 was chosen as the better of the two sites. Detailed location of this site is shown on Plate J23.

Design and cost features of these selected irrigation reservoirs are listed in Table J40. The cost data includes the costs of distribution to individual farms.

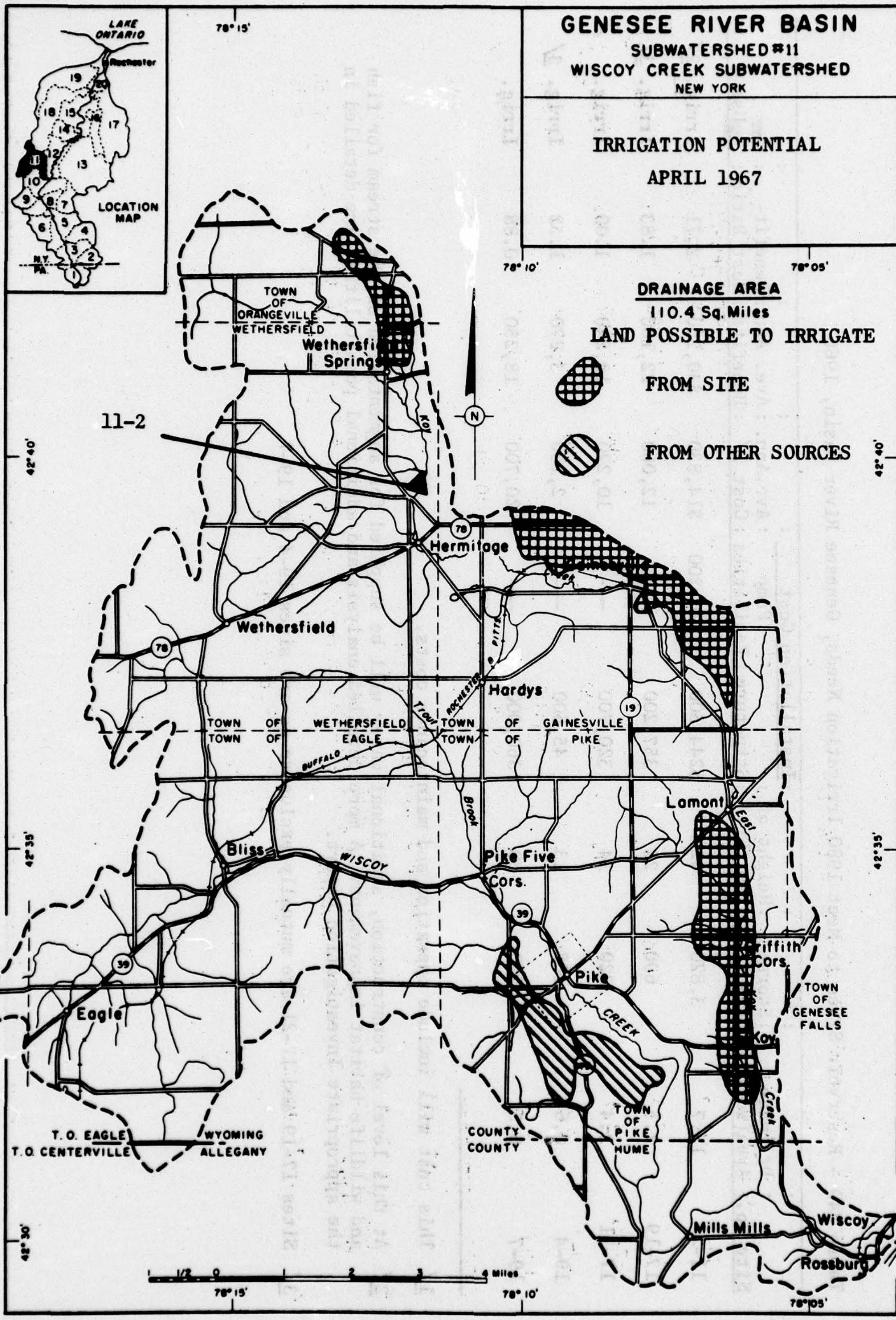
Table J40 - Reservoir Sites to Meet 1980 Irrigation Needs, Genesee River Basin, 1966

Site No.	Drainage Area (sq.mi.)	Storage (Ac.Ft.)	Height of Dam (Ft.)	Installation Cost: Structure	Installation Cost: Pump Facilities	Ave. Ann. Cost 1/	Ave. Ann. Benefits	Benefit-Cost Ratio	Use
11-2	11.7	3,820	42	$244,500	$70,200	$14,830	$40,260	2.71	Irrig. 2/
17-19	7.5	690	23	357,200	---	12,060	22,100	1.83	Irrig. 3/
17-21	2.4	320	14	320,700	---	10,220	10,240	1.00	Irrig.
19-4	0.6	102	13	45,600	---	2,150	3,270	1.52	Irrig. 3/
19-7	6.5	570	30	360,000	---	20,700	18,250	0.88	Irrig.

1/ This cost will include operation and maintenance costs.

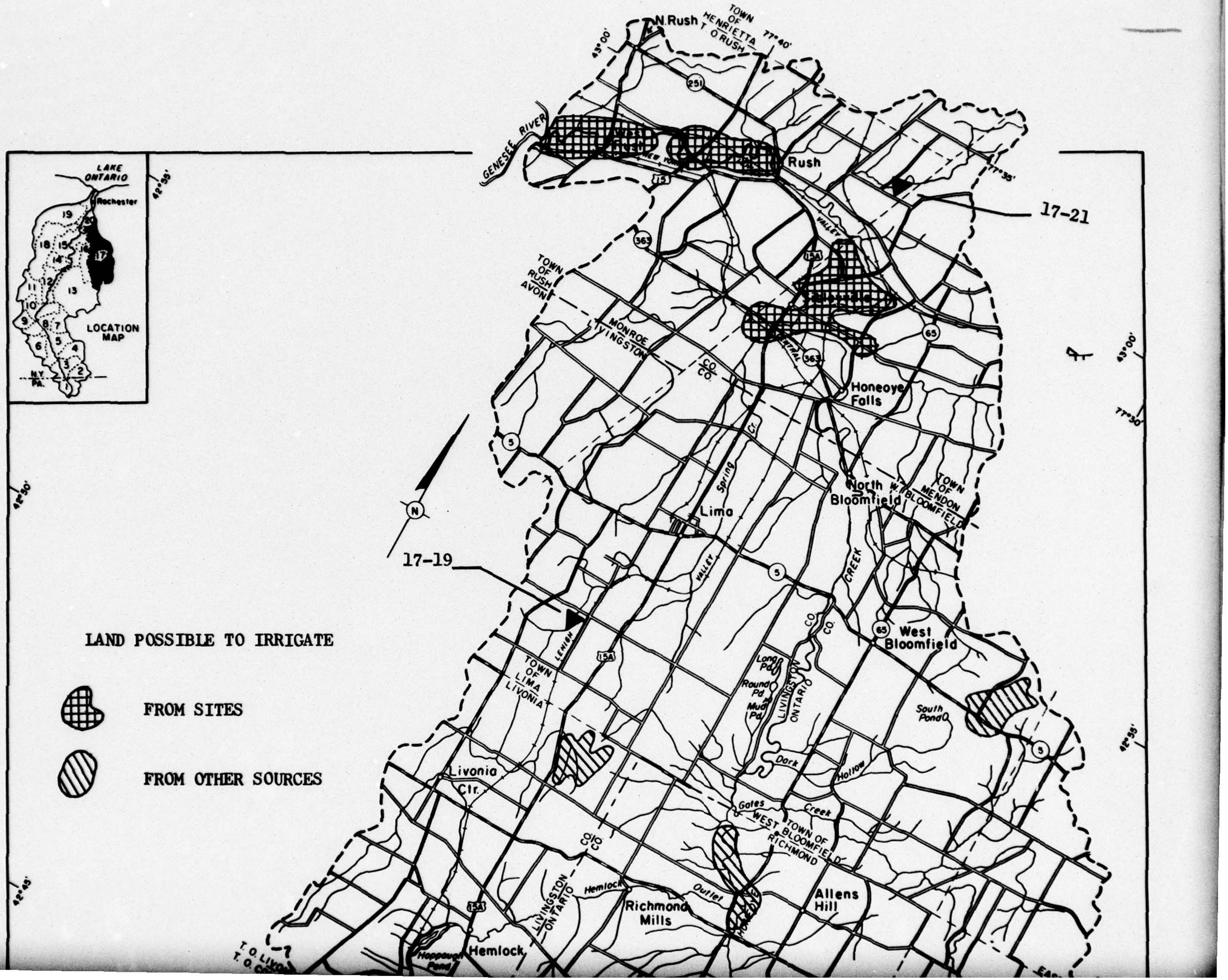
2/ At this level of construction, additional water will be supplied for augmentation of the stream for fish and wildlife habitat improvement. A more detailed analysis and additional possibilities are detailed in the appropriate Investigation Report.

3/ Sites 17-19 and 17-21 are mutually exclusive as are sites 19-4 and 19-7.

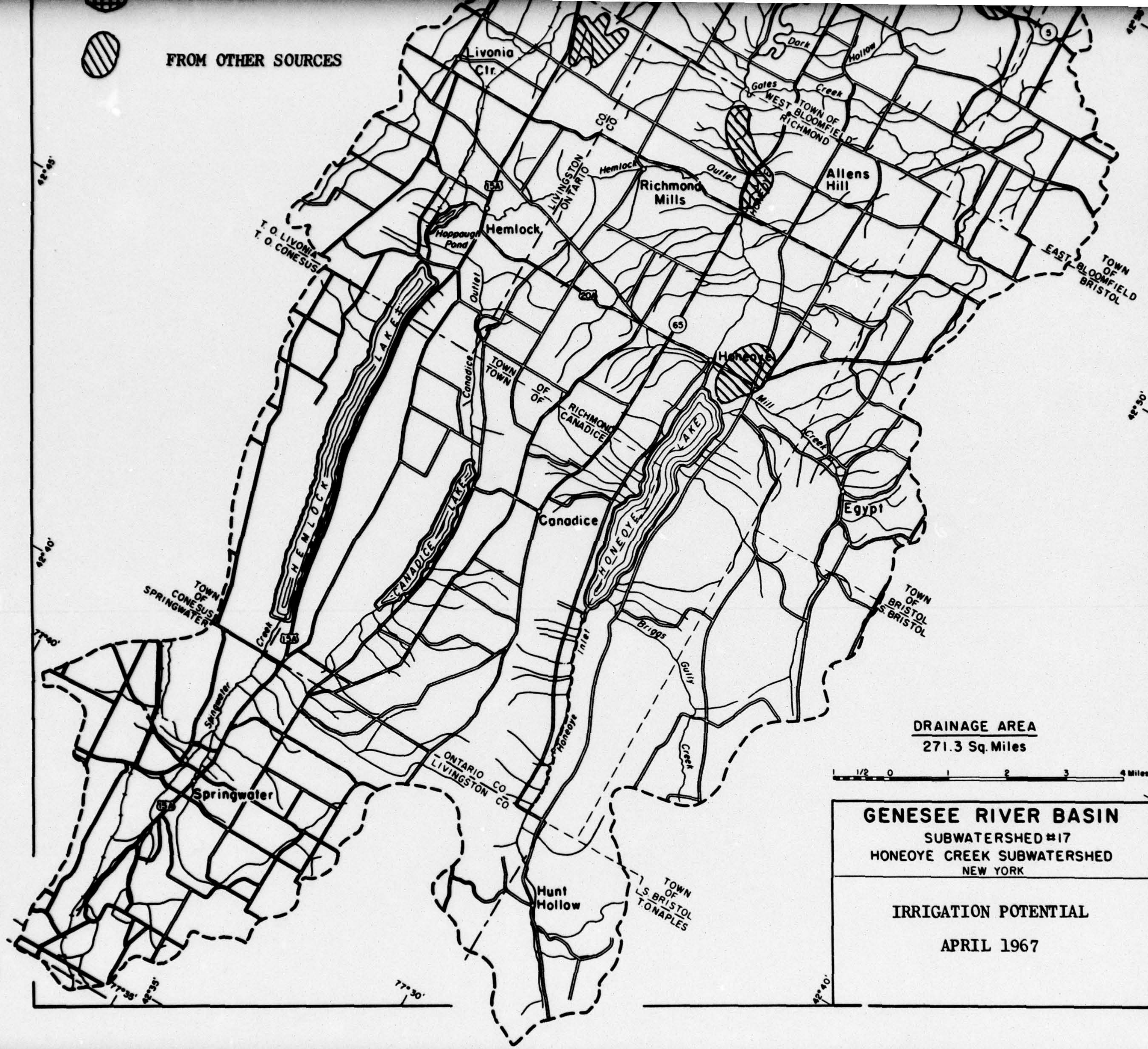


GENESEE RIVER BASIN
SUBWATERSHED #11
WISCOY CREEK SUBWATERSHED
NEW YORK
IRRIGATION POTENTIAL
APRIL 1967
DRAINAGE AREA
110.4 Sq. Miles
LAND POSSIBLE TO IRRIGATE
FROM SITE
FROM OTHER SOURCES
LAKE ONTARIO
Rochester
LOCATION MAP
11-2
TOWN OF ORANGEVILLE
WETHERSFIELD
Wethersfield Springs
Hermitage
Wethersfield
Hardys
TOWN OF WETHERSFIELD
TOWN OF EAGLE
TOWN OF GAINESVILLE
TOWN OF PIKE
Lamont
Bliss
Pike Five Cors.
Griffith Cors.
Pike
Eagle
Koy
TOWN OF GENESEE FALLS
TOWN OF PIKE
HUME
T. O. EAGLE
T. O. CENTERVILLE
WYOMING
ALLEGANY
COUNTY
COUNTY
Mills Mills
Wiscoy
Rossburg
GENESEE RIVER
WISCOY
CREEK
BUFFALO
Trout
Brook
East
Koy
Creek
78° 15'
78° 10'
78° 05'
42° 40'
42° 35'
42° 30'
4 Miles

Plate J21



LAND POSSIBLE TO IRRIGATE
FROM SITES
FROM OTHER SOURCES
LAKE ONTARIO
Rochester
LOCATION MAP
N.Y.
PA.
17-21
17-19
N
N.Rush
TOWN OF HENRIETTA
T. O. RUSH
GENESEE RIVER
Rush
TOWN OF RUSH
AVON
MONROE
LIVINGSTON
CO.
CO.
Honeoye Falls
North Bloomfield
TOWN OF MENDON
W. BLOOMFIELD
Lima
Spring
Cr.
VALLEY
CREEK
West Bloomfield
LEHIGH
TOWN OF LIMA
LIVONIA
Long Pd
Round Pd
Mud Pd
LIVINGSTON
ONTARIO
South Pond
Dark
Hollow
Livonia Ctr.
Gates
Creek
WEST BLOOMFIELD
TOWN OF RICHMOND
Allens Hill
Outlet
Hemlock
Richmond Mills
Hemlock
Hemlock Pond
43°00'
77°40'
77°35'
77°30'
42°55'
42°50'
42°45'

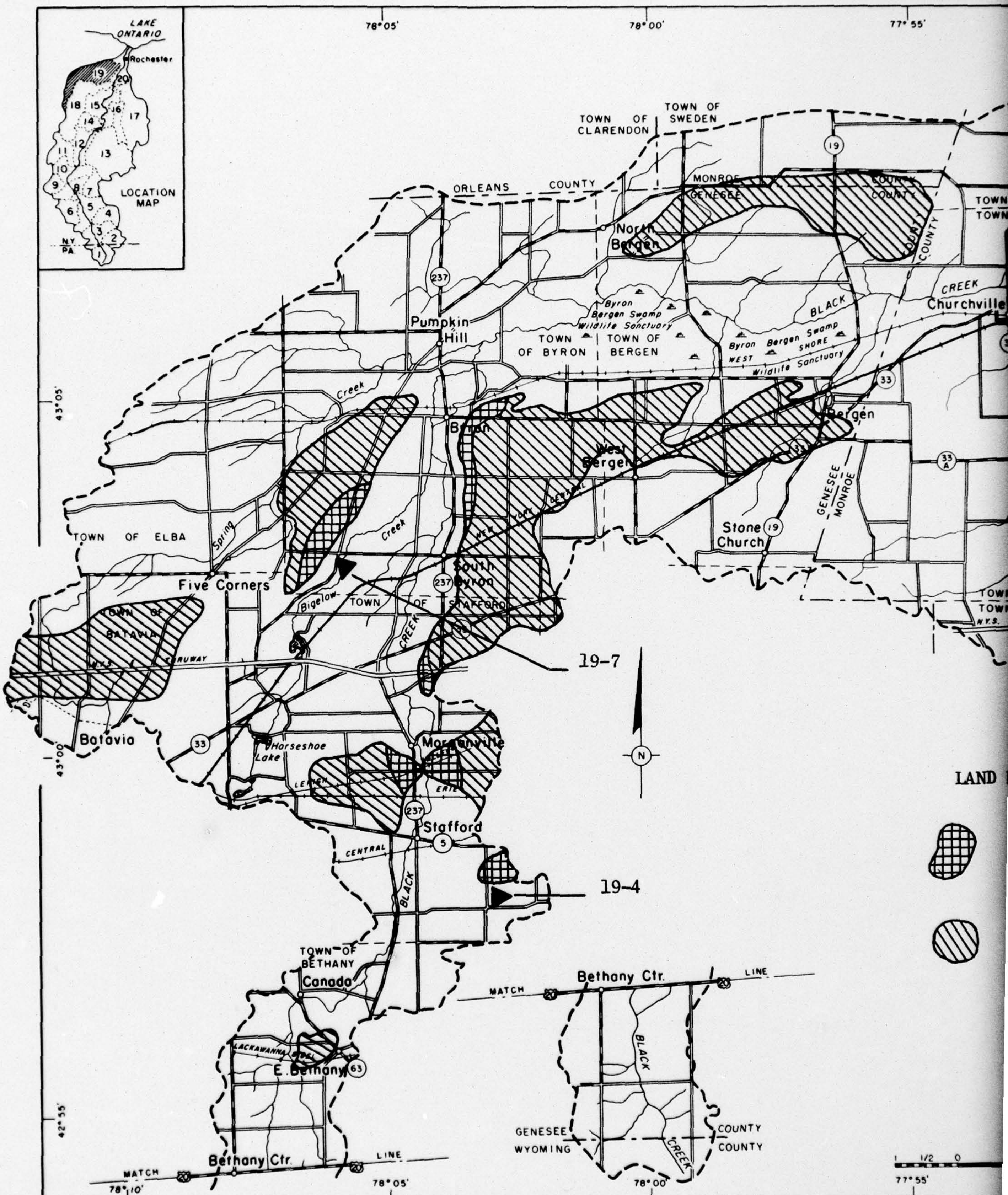


GENESEE RIVER BASIN
SUBWATERSHED #17
HONEOYE CREEK SUBWATERSHED
NEW YORK

IRRIGATION POTENTIAL

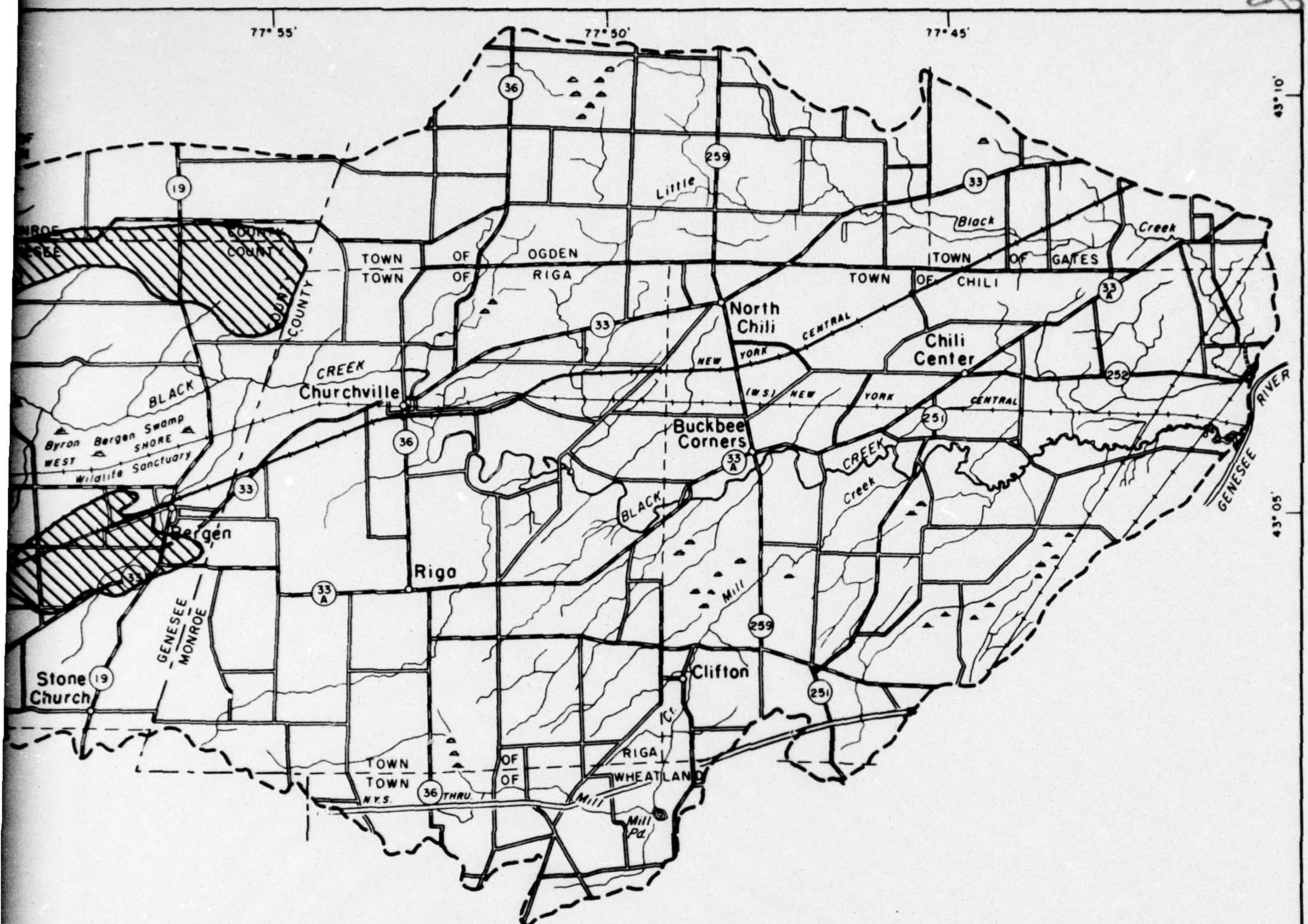
APRIL 1967

2



LAKE ONTARIO
Rochester
LOCATION MAP
N.Y.
PA.
78°05'
78°00'
77°55'
TOWN OF CLARENDON
TOWN OF SWEDEN
ORLEANS COUNTY
MONROE COUNTY
GENESEE COUNTY
North Bergen
Pumpkin Hill
Byron Bergen Swamp Wildlife Sanctuary
TOWN OF BYRON
TOWN OF BERGEN
Byron Bergen Swamp West Shore Wildlife Sanctuary
BLACK CREEK
Churchville
Bergen
Byron
West Bergen
TOWN OF ELBA
Spring Creek
Stone Church
GENESEE MONROE
Five Corners
South Byron
Bigelow
TOWN OF STAFFORD
TOWN OF BATAVIA
19-7
Batavia
Horseshoe Lake
Morganville
Stafford
CENTRAL
BLACK
19-4
LAND
TOWN OF BETHANY
Canada
Bethany Ctr.
MATCH LINE
LACKAWANNA
E. Bethany
GENESEE COUNTY
WYOMING COUNTY
CREEK
43°05'
43°00'
42°55'
78°10'

J135 (J136)



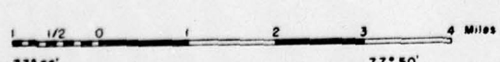
LAND POSSIBLE TO IRRIGATE

FROM SITE

FROM OTHER SOURCES

DRAINAGE AREA

213.9 Sq. Miles



GENESEE RIVER BASIN

SUBWATERSHED #19

BLACK CREEK SUBWATERSHED

NEW YORK

IRRIGATION POTENTIAL

APRIL 1967

Plate J23

Fish and Wildlife. The projected needs of the fish and wildlife resource of the Basin are developed in the Task Group 9 report. These needs are shown in terms of projected annual use-days by decade. From the list of potential sites determined by Task Group 5, those sites feasible for fish and wildlife habitat were indicated for further study. These preliminary selections were designed, costs were estimated, and tentative benefits determined. Then, formulation of the plan was based upon the economic feasibility of the site and its potential for helping to meet the needs of the future. In combination with the structures proposed in the main report, the structures recommended here come very near to meeting the 1980 needs for cold water fishing in the Basin. However, proposed waterfowl habitat sites were generally found to be too expensive for justification. It is felt that much of this type of development can be carried out under current state programs which utilize different design criteria and may result in lower installation costs.

In total, 20 impoundment sites were included in the plan for fish and wildlife development. The general location of these sites is shown on Plate J24, while relevant data on each site is given in Table J41.

Of the listed sites, 6 will also serve a second primary purpose of recreation and one is an irrigation site which will also supply augmentation water to a trout stream. It should be noted that the majority of the sites in the Basin will provide fish and wildlife benefits incidental to some primary purpose. Because of the stable pool level, recreation sites will go furthest towards providing these benefits, but they will also accrue in some measure to nearly all of the other sites. Also noted here is the contribution of these type of structures to rural development. While not strictly part of the agricultural resource, these developments provide large increases in rural wealth through increases in commercial activity, greater opportunity for the rural labor force, increased value of farms and rural property and in recreational opportunity for rural residences.

Recreation. Sites recommended for recreation development and use are those recommended by Task Group 8, Recreation Studies, in cooperation with Task Group 9, Fish and Wildlife Studies. The formulation procedure followed was quite similar to that followed for selection of Fish and Wildlife sites, in that all sites were screened for physical and economic feasibility first and then chosen on their ability to meet a total projected recreation need.

Factors affecting the structural selection include the availability of access, fluctuation and size of water surface, characteristics of surrounding terrain and vegetation, dependability of water yield, geologic conditions and the presence of alternative or complementary uses.

The costs shown in Table J42 reflect additional land acquisition and road construction considered necessary to derive the given level of benefits for recreational development. It should be noted that the costs of facilities were not determined from an individual plan for each site, but are derived from typical costs necessary to service the projected recreation users of each site.

Table J41 - Reservoir Sites to Meet 1980 Fish and Wildlife Needs, Genesee River Basin, 1966

Site No.	Drainage Area (Sq.Mi.)	Surface Acres	Height of Dam (Ft.)	Installation Cost: Structure ($1000)	Installation Cost: Facilities ($1000)	Aver.Ann. Cost	Aver.Ann. Benefits 1/	Benefit-Cost Ratio	Other Uses 2/
3-1	23.7	216	102	1,983	2	67,160	114,000	1.70	-
3-4	10.4	156	65	1,886	251	107,460	139,900	1.30	Rec
5-21	1.6	86	59	357	2	12,270	45,000	3.67	-
7-1	17.6	127	65	651	2	22,210	59,800	2.69	-
7-2	15.7	1715	50	1,503	412	122,740	855,000	6.97	Rec
8-13	2.8	227	39	322	144	36,070	162,000	4.49	Rec
9-3	6.7	72	77	833	2	28,340	31,000	1.09	-
10-3	2.7	122	39	245	2	8,480	64,000	7.55	-
11-2	11.7	-	33	245	70	10,620	40,260	3.79	I
11-4	1.8	92	53	477	2	16,300	48,000	2.95	-
13-1	5.0	60	119	758	2	25,800	32,000	1.24	-
13-6	16.3	243	47	833	250	71,860	172,900	2.41	Rec
13-22	19.1	94	85	1,005	2	34,100	50,000	1.47	-
14-4	1.1	90	79	417	2	14,170	47,000	3.32	-
14-5	2.2	90	89	496	2	16,820	47,000	2.79	-
15-2	10.0	720	31	617	185	53,250	58,400	1.10	Rec
17-1	2.7	202	48	981	2	33,360	107,000	3.20	-
17-7	12.6	124	142	1,260	2	42,390	65,000	1.53	FP
17-8	2.1	215	66	492	2	16,670	90,000	5.40	-
17-24	3.1	258	44	367	247	55,590	181,000	3.26	Rec

1/ This column contains preliminary Fish and Wildlife benefits plus benefits from other sources.

2/ Rec - recreation; I - irrigation; FP - minor flood prevention possibilities.

Table J42 - Reservoir Sites to Meet 1980 Recreation Needs, Genesee River Basin, 1966. 1/

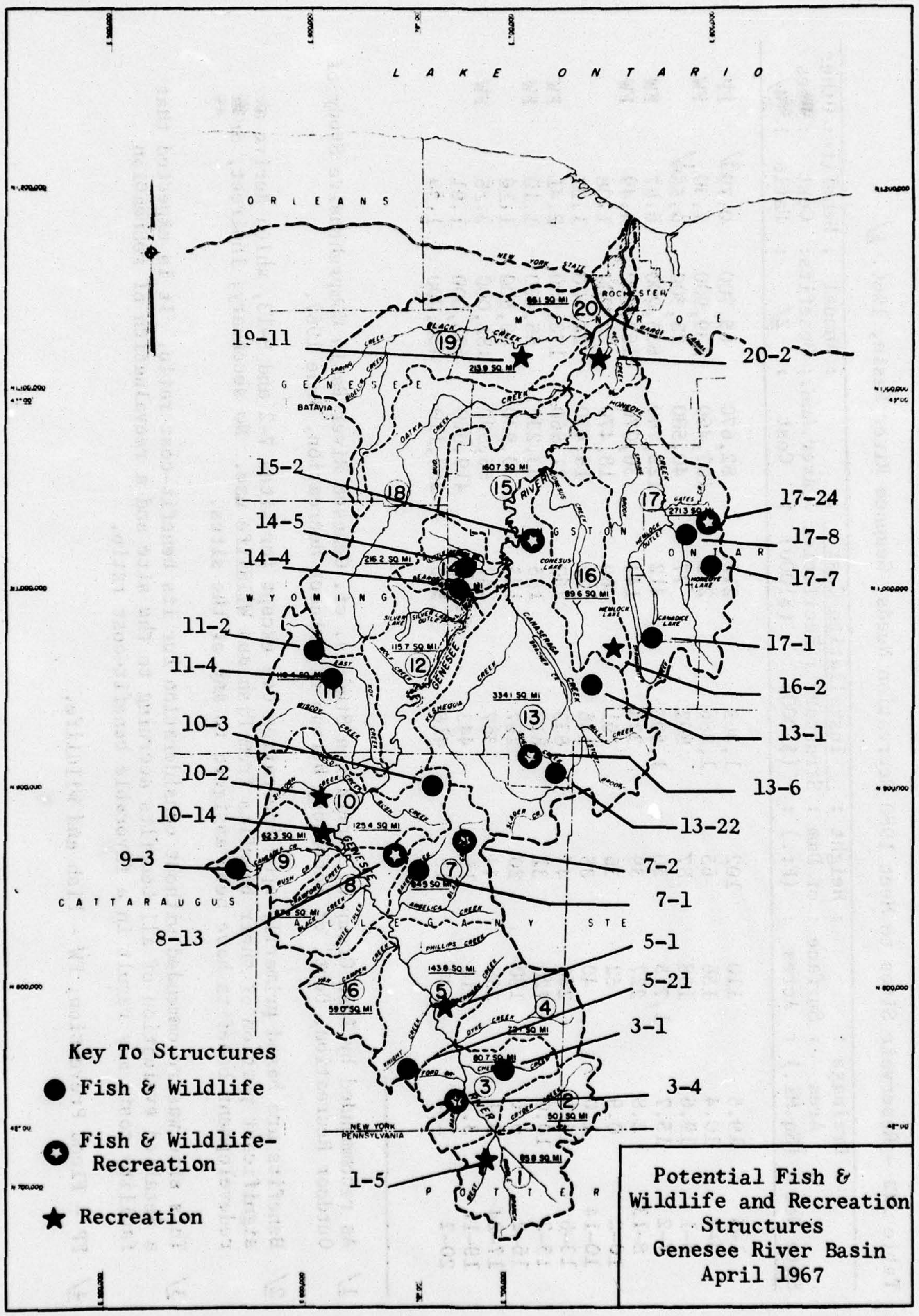
Site No.	Drainage Area (Sq.Mi.)	Surface Acres	Height of Dam (Ft.)	Installation Cost: Structure ($1000)	Installation Cost: Facilities ($1000)	Aver.Ann. Cost	Annual Benefits 2/	Benefit-Cost Ratio	Other Uses 4/
1-5	19.5	110	102	1,469	213	82,670	65,700	0.79 3/	FP
3-4	10.4	156	65	1,886	251	107,460	139,900	1.30	FW
5-1	19.6	138	87	802	77	40,580	22,500	0.55 3/	
7-2	15.7	1,715	50	1,503	412	122,740	855,000	6.97	FW
8-13	2.8	227	39	322	144	36,070	162,000	4.49	FW
10-2	0.9	52	36	191	69	18,470	20,000	1.08	
10-14	1.0	40	35	146	77	18,430	22,500	1.22	
13-6	16.3	243	47	833	250	71,860	172,900	2.41	FW
15-2	10.0	720	31	617	185	53,230	58,400	1.10	FW
16-2	6.6	180	20	267	125	30,930	36,500	1.18	
17-24	3.1	258	44	367	247	55,590	181,000	3.26	FW
19-11	3.3	315	18	443	2,318	419,960	675,000	1.61	
20-2	1.3	140	18	418	1,545	284,110	450,000	1.58	

1/ As recommended by Task Group 9, Recreation Studies. cf. Genesee River Basin Comprehensive Study of Outdoor Recreation, Dept. of Interior, Bureau of Outdoor Recreation, June 1967.

2/ Benefits are based primarily upon Recreation Use except for sites 7-2 and 8-13, which derive a significant portion of their benefits from Fish and Wildlife use. No secondary, indirect, or redevelopment benefits have been assigned to any of the sites.

3/ This site was recommended without consideration for its benefit-cost ratio. It is expected that a detailed evaluation of all benefits accruing to the site and a reevaluation of recreation facility costs may result in a favorable benefit-cost ratio.

4/ FP - Flood Prevention; FW - Fish and Wildlife.



LAKE ONTARIO
ORLEANS
ROCHESTER
MONROE
GENESEE
BATAVIA
LIVINGSTON
ONTARIO
WYOMING
CATTARAUGUS
ALLEGANY
STEUBEN
POTTER
NEW YORK
PENNSYLVANIA
19-11
20-2
15-2
14-5
14-4
11-2
11-4
10-3
10-2
10-14
9-3
8-13
17-24
17-8
17-7
17-1
16-2
13-1
13-6
13-22
7-2
7-1
5-1
5-21
3-1
3-4
1-5
Key To Structures
Fish & Wildlife
Fish & Wildlife-Recreation
Recreation
Potential Fish & Wildlife and Recreation Structures
Genesee River Basin
April 1967

Plate J24

As mentioned earlier in this report, site 1-5 would include some significant flood control benefits as a second increment. Six other sites will include fish and wildlife benefits as an additional primary purpose and the remainder of the sites will offer at least incidental fish and wildlife benefits. Because of the high degree of compatibility between these uses, Plate J24 (page J140) depicts the general recreation site locations as well as those recommended for fish and wildlife use.

Water Quality Management. A description of the low flow needs of the Genesee River Basin is given in Task Group No. 4 report. From these projected needs and the preliminary site inventory, it was possible to locate those sites which had a yield great enough to supply the supplemental water. The economic feasibility of these sites was determined by estimating the annual alternative cost of advance treatment and comparing this with the annual cost of constructing, maintaining and operating the potential site. Where the annual cost of augmentation was less than the alternative cost of treatment, the site was determined to be feasible.

Three small watershed impoundment structures were determined to be in the range of justification and may be considered as alternatives to advance treatment systems in formulation of the Basin program. They provide supplemental water for Mill Creek below Wayland, Wilkins Creek below Livonia and Oatka Creek below Warsaw. In addition, a site which augments Honeoye Creek below Honeoye Falls comes very close to justification and is included because of the potential additional benefits due to fish and wildlife habitat enhancement, incidental recreation benefits and other possible benefits. The data and costs of these sites are given in Table J43 and their general location is shown in Plate J25.

Water Supply. Task Group 4 determined projected water supply needs by municipal and industrial water users in the Genesee River Basin. An inventory of sites potentially capable of supplying this water was then made. Eleven sites were tentatively selected in this process. In a subsequent screening based upon, costs, ground water availability, and local interest, this list was reduced to one site, 18-7. This structure would supply water for the village of Warsaw which has expressed its need for and interest in the site. The location of this site is shown on Plate J25 while data and costs are shown in Table J44.

It should be recognized that no provision has been made for the inclusion of the cost of special gated release, distribution pipeline, or other such expense. The cost presented is for construction only. Any changes in structural dimension, materials, or design criteria will necessitate a revision in estimated structure cost.

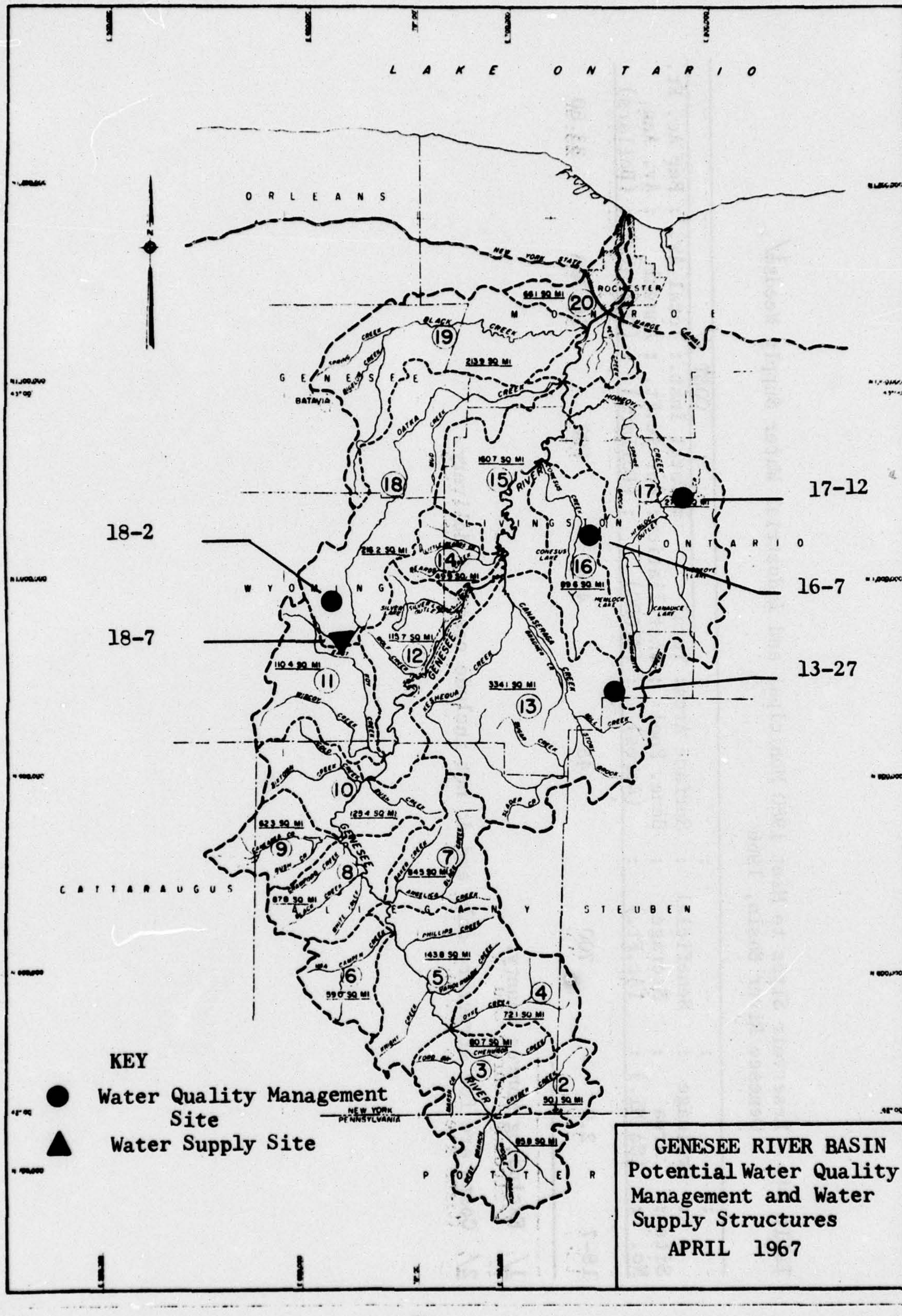
Table J43 - Reservoir Sites to Meet 1980 Water Quality Control Needs, Genesee River Basin, 1966

Site No.	Drainage Area (Sq.Mi.)	Beneficial Storage (Ac.Ft.)	Average Release Provided (CFS)	COSTS Installation ($1000)	Per A.F. Beneficial Storage (Dollars)	Per Contin. CFS Provided ($1000)	Average Annual Cost (Dollars)	Benefits 1/ (Dollars)	Benefit-Cost Ratio	Problem Area
13-27	0.8	230	0.23	273	1187	1187	9,220	13,500	1.46	Mill Cr. Below Wayland
16-7	0.7	328	0.35	157	479	449	5,300	10,000	1.89	Wilkins Cr. Below Livonia
17-12	17.0	6660	3.70	686 2/	105	185	23,160	19,800	0.85 3/	Honeoye Cr. Below Honeoye Falls
18-2	2.4	1488	1.30	308	207	237	10,400	37,500	3.61	Oatka Cr. Below Warsaw

1/ Limited to minimum alternative cost of advance treatment facilities.

2/ Does not include disposition of gas wells or pipelines in pool area.

3/ Evaluation of additional benefits in detailed planning stage could perhaps justify this site.



GENESEE RIVER BASIN
Potential Water Quality Management and Water Supply Structures
APRIL 1967

Plate J25

Table J44 - Reservoir Sites to Meet 1980 Municipal and Industrial Water Supply Needs 1/, Genesee River Basin, 1966

Site No.	Drainage Area (Sq.Mi.)	Beneficial Storage (Ac.Ft.)	Surface Area: Bene. Pool (Acres)	COST 2/ Total Installation ($1000)	Total Inst. Per Ac.Ft. (Dollars)	Total Av. Annual (Dollars)	Per Ac. Ft. Av. Ann. (Dollars)
18-7	2.9	700	45	484	690	16,300	23.60

1/ Excluding Monroe County.

2/ Costs are for structure only and do not include costs of delivery.

Summary of Program for Current Needs. The upland program as presented here is not a sterile assessment of projected needs and possible solutions, but is a reflection of the growing awareness by an educated public of the possibilities of needed water resource development. As evidence of this need, requests have been received from both public and private organizations on several of the recreation structures in the southern part of the Basin. A county in the northern portion of the Basin has incorporated two of the proposed recreation structures in its master plan for recreation. A village has requested further information on a water supply structure and farmers are discussing their participation in an irrigation structure.

In addition to this interest, the State of New York has already entered into a program to participate in cost-sharing of lands needed for fish, wildlife and recreation developments. It is also assumed that the Bureau of Outdoor Recreation could facilitate developments such as the Birdsall site 7-2 through its Land and Water Conservation Fund.

Table J45 summarizes the potential upstream program; its total cost and the anticipated extent of participation by the Federal Government.

Due to legislative restrictions, the program proposed here could not be implemented entirely under Public Law 566. Only those watersheds which include flood control or agricultural water management as primary purposes are eligible for construction with federal cost sharing. All of the potential irrigation structures in the Ontario Lake Plains Service Area can be constructed under the current program. Only 3 of the 20 Basin watersheds fall in this category - Watersheds 11, 17 and 19.

Within these 3 eligible watersheds, there are also single purpose recreation and fish and wildlife structures which could not be included in a plan for construction. Because of these ineligible features, only 5 of the 34 potential Basin structures could become part of any P.L. 566 plans. The remaining structures will require Basin-wide authorization if 1980 water resource needs are to be met.

Program for Future Needs

During the course of the study, preliminary engineering and cost information was developed for many additional reservoir sites. These sites were considered in the program for present needs but were not determined to have a present use capability. Particular engineering features and costs of all the structures are presented in the attachment to this report, "Preliminary Upstream Reservoir Studies - Genesee River Basin," prepared by the U. S. Department of Agriculture in August 1966.

As future water resource needs become better known, reference to this list of potential structures should be made to determine which of the structures offer possibilities for development. These sites are listed in Table J46. Because of the large number of sites, their location is not given here but may be seen in the previously mentioned publication, "Preliminary Upstream Reservoir Studies."

Table J45 - Summary of Structural Works to be Installed in Program to Meet 1980 Needs, Genesee River Basin, 1967.

Development Site Number	Needs Met 1/	Estimated Total Cost	Estimated Cost of Federal Participation 2/
1-5	Rec, FP	$1,682,000	$1,230,790
3-1	FW	1,985,000	992,500
3-4	Rec, FW	2,137,000	1,068,500
5-1	Rec	879,000	439,500
5-21	FW	359,000	179,500
7-1	FW	653,000	326,500
7-2	Rec, FW	1,915,000	957,500
8-13	Rec, FW	466,000	233,000
9-3	FW	835,000	417,500
10-2	Rec	260,000	130,000
10-3	FW	247,000	123,500
10-14	Rec	223,000	111,500
11-2	I, FW	314,700	157,350
11-4	FW	479,000	239,500
13-1	FW	760,000	380,000
13-6	Rec, FW	1,083,000	541,500
13-22	FW	1,007,000	503,500
13-27	WQ	273,000	--
14-4	FW	419,000	209,500
14-5	FW	498,000	249,000
15-2	Rec, FW	802,000	401,000
16-2	Rec	392,000	196,000
16-7	WQ	157,000	--
17-1	FW	983,000	491,500
17-7	FW, FP	1,262,000	793,500
17-8	FW	494,000	247,000
17-12	WQ	686,000	--
17-19	I	357,200	178,600
17-24	Rec, FW	614,000	307,000
18-2	WQ	308,000	--
18-7	MI	484,000	--
19-4	I	45,600	22,800
19-11	Rec	2,761,000	1,380,500
20-2	Rec	1,963,000	981,500
Basin Sub-totals		$27,783,500	$13,490,040
Ontario Lake Plains 3/ Sub-totals		5,185,000	2,592,500
PROGRAM TOTAL		$32,968,500	$16,082,540

1/ Rec - Recreation; FP - Flood Prevention; WQ - Water Quality Control; FW - Fish & Wildlife; I - Irrigation; MI - Municipal or Industrial Water Supply.
2/ Based upon current P.L. 566 Cost Sharing Criteria for these purposes.
3/ See Tables J50 and J51 on pages J160 and J161 for this portion of the program.

Table J46 - Additional Sites to Meet Future Needs, Genesee River Basin, 1966

Site No.	Drainage Area (Square Miles)	Beneficial Storage (Acre Feet) 1/	Surface Area Bene. Pool(Acres)
1-3	12.9	None	None
1-6	3.2	None	None
1-7	54.7	None	None
1-8	34.0	None	None
2-3	14.8	4938	145
2-6	18.3	None	None
2-10	50.1	None	None
3-2	10.4	None	None
3-3	11.3	7730	176
4-1	5.8	400	28
4-2	19.9	6951	180
4-4	5.2	None	None
4-5	7.1	4540	133
5-13	24.8	None	None
5-14	6.0	None	None
5-16	10.5	None	None
5-18	5.3	1810	60
6-3	5.8	600	36
6-5	11.8	7550	220
6-6	3.7	None	None
6-7	5.9	None	None
7-3	11.7	None	None
7-7	33.2	8900	313
8-2	12.4	5935	156
8-10	6.2	3970	120
10-4	11.8	4880	178
10-7	32.0	6210	160
10-10	13.5	8110	256
10-16	6.9	4416	156
11-1	3.3	2670	107
11-9	7.6	4870	196
11-10	12.8	2520	285
12-1	9.7	1823	155
12-2	0.4	170	30
13-2	2.7	None	None

1/ Sites without beneficial storage were developed for flood prevention only.

Table J46 - Continued

Site No.	Drainage Area (Square Miles)	Beneficial Storage (Acre Feet) 1/	Surface Area Bene. Pool (Acres)
13-3	8.1	480	48
13-5	17.7	9617	210
13-8A	4.0	None	None
13-10	5.8	2453	75
13-11	6.8	1692	57
13-13	19.1	4551	150
13-24	1.8	984	31
14-3	6.3	4350	400
14-2	4.9	3275	280
15-3	5.8	1277	195
15-4	2.0	563	88
15-5	3.5	912	160
15-6	0.8	1497	182
15-7	7.8	575	150
15-8	5.4	688	130
15-9	2.4	2200	201
16-4	16.1	7343	710
16-5	1.2	310	67
17-3	0.5	192	34
17-5	18.0	6412	1100
17-6	3.0	4102	252
17-11	1.1	723	109
17-21	2.4	1462	255
17-22	0.7	789	204
18-5	1.7	663	138
18-6	2.9	700	158
18-8	4.2	1300	170
18-9	1.5	718	73
19-7	6.5	2435	220
19-9	4.6	1950	275
19-10	1.0	264	110
20-1	0.4	298	75

1/ Sites without beneficial storage were developed for flood prevention only.

IRRIGATION ON THE LAKE PLAIN SERVICE AREA

INTRODUCTION

The Ontario Lake Plain Service Area is a region of about 482,000 acres lying between Lockport and Rochester along the southern shore of Lake Ontario. The land is flat to gently rolling and slopes downward from its southern boundary to bluffs along the lake shore. The soils range from moderately to highly productive and comprise one of the major fruit and vegetable crop producing regions of New York State.

The mean average growing season rainfall is below that of the rest of the state, and in many years is insufficient to produce good vegetable crops. With several exceptions drainage areas are small and growing season streamflow is extremely restricted. Similarly, groundwater sources are also limited. A good deal of reliance is placed upon the Barge Canal as a source of irrigation water at present. The effective limit on the amount of water which can be drawn from this source has perhaps been reached and indeed, may already have been passed.

Because of the high general productivity of this region and due to its close proximity to the Genesee River Basin, the potential for development of irrigation water supplies was studied concurrently with the Genesee River Basin.

PRESENT IRRIGATION WATER PROBLEMS

In 1959, the various watersheds comprising the Ontario Lake Plains harvested 23,000 acres of vegetable crops while irrigating only about 3,820 acres. It is expected that competition, quality, and yield requirements will increase irrigation demand in the near future. The following narrative attempts to determine what problems are faced in providing additional water supplies for the unirrigated acres and also what means are available to attain this supply.

The practice of supplementing rainfall with irrigation is important to growers on the Ontario Lake Plain. The increasing acceptance of irrigation to maintain a sustained intensified agricultural program is evident upon looking at past records.

Table J47.--Six Year Growth in Irrigation Along the New York State Barge Canal, Sixty Mile Level Area 1/, 1950 through 1955.

Year	Number of Farms	Acres Irrigated
1950	19	600
1951	24	626
1952	35	1370
1953	44	1535
1954	68	2482
1955	84	3259

Source: Report of the Temporary State Commission on Irrigation, 1957, Legislative Document (1957) No. 27.

1/ The area covered by this table is not identical with the Ontario Lake Plain Service Area and is used to show trend only.

The previous table indicates an increase of over 500 percent in the number of acres irrigated along the sixty mile level from 1950 to 1955.

Data from the Census of Agriculture indicates that approximately 3820 acres were under irrigation on the Ontario Lake Plain Service Area in 1959. Of the counties making up the Service Area, Orleans County ranks fourth out of 62 counties in terms of acres irrigated while Monroe ranks third and has the largest acreages under irrigation on the Lake Plain. Niagara County ranks eleventh according to the Census. Preliminary data from the 1964 Census of Agriculture indicates that an estimated 5450 acres were irrigated during that year; a 29.9 percent increase in area in five years.

It is generally felt that these increases in irrigation water use have come about in response to overall demand for uniform quality plus farmers' desire to improve yields. It is expected that eventually irrigation will be required in this area in order to meet these demands.

Crops irrigated on the Lake Plain are the major truck crops, such as tomatoes, cabbage, peas, beans, cauliflower, onions, beets and some fruits. These crops meet fresh market as well as processing demands. Due to the high population concentrations near this region, there is a heavy demand for such crops and none of them are in national surplus. Some lower value crops in a rotation may also be irrigated due to the availability of a fixed supply of water and equipment.

The Ontario Lake Plains Area is also noted for its tree fruit production, but the value of, or the necessity for providing irrigation water for these crops is not known. Several recent research reports have been inconclusive on the subject, and therefore no provision has been made for the irrigation of these deep rooted crops although some will likely be irrigated.

Within the Ontario Lake Plains Service Area, there are extensive acreages of soil types with slopes suitable for irrigation. Of the total 182,990 irrigable acres, about 23,810 acres would require no drainage and the remaining 159,180 acres would require only random drainage in order to be irrigated. These areas are shown on Plate J26 and listed by watershed in Table J48.

Table J48.--Irrigable Land in the Ontario Lake Plains Service Area by Drainage Needs

Watershed	Land Capable of Being Irrigated: No Drainage Needed (acres)	Land Capable of Being Irrigated: Random Drainage Needed (acres)	Total (acres)
A	1,210	12,290	13,500
B	1,700	14,320	16,020
C	4,140	26,630	30,770
D	4,760	25,270	30,030
E	2,830	20,980	23,810
F	2,100	44,680	46,780
G	7,070	15,010	22,080
Total	23,810	159,180	182,990

As mentioned previously, the Census of Agriculture indicated that only 5,450 acres were irrigated in 1964. Many items account for such a small portion of the irrigable land being presently irrigated. Some of the items are associated with the physical availability of water while others pertain to technological, social, and legal aspects of irrigation. Some of these items will grow in importance in the future, while some will decrease. Principal items are:

1. Lack of sufficient quantities of water - many farms are not located near streams or appreciable bodies of water and do not have sufficient ground water supplies to make irrigation possible.

2. Uncertainty as to future water supply - land which could be irrigated from the Barge Canal may not be under irrigation because the owners fear cancellation of their water use permit.

3. Uncertainty as to technology - irrigation is relatively new to the area and farmers may not innovate until they are shown how by local group leaders.

4. Uncertainty as to the benefits derived from irrigation - research at the state and regional level has not indicated what actual increased monetary returns are possible from irrigation.

5. Lack of management skill - irrigation requires considerable management skill which may not be available on all farms.

6. Lack of capital - irrigation equipment has a high initial cost which may be prohibitive in capital scarce areas and for certain farmers.

7. Labor shortage - irrigation requires extra labor supplies during a critically labor-short period.

8. Legal restrictions - riparian water rights may prevent an upstream landowner from using water if a downstream owner's use is thereby impaired.

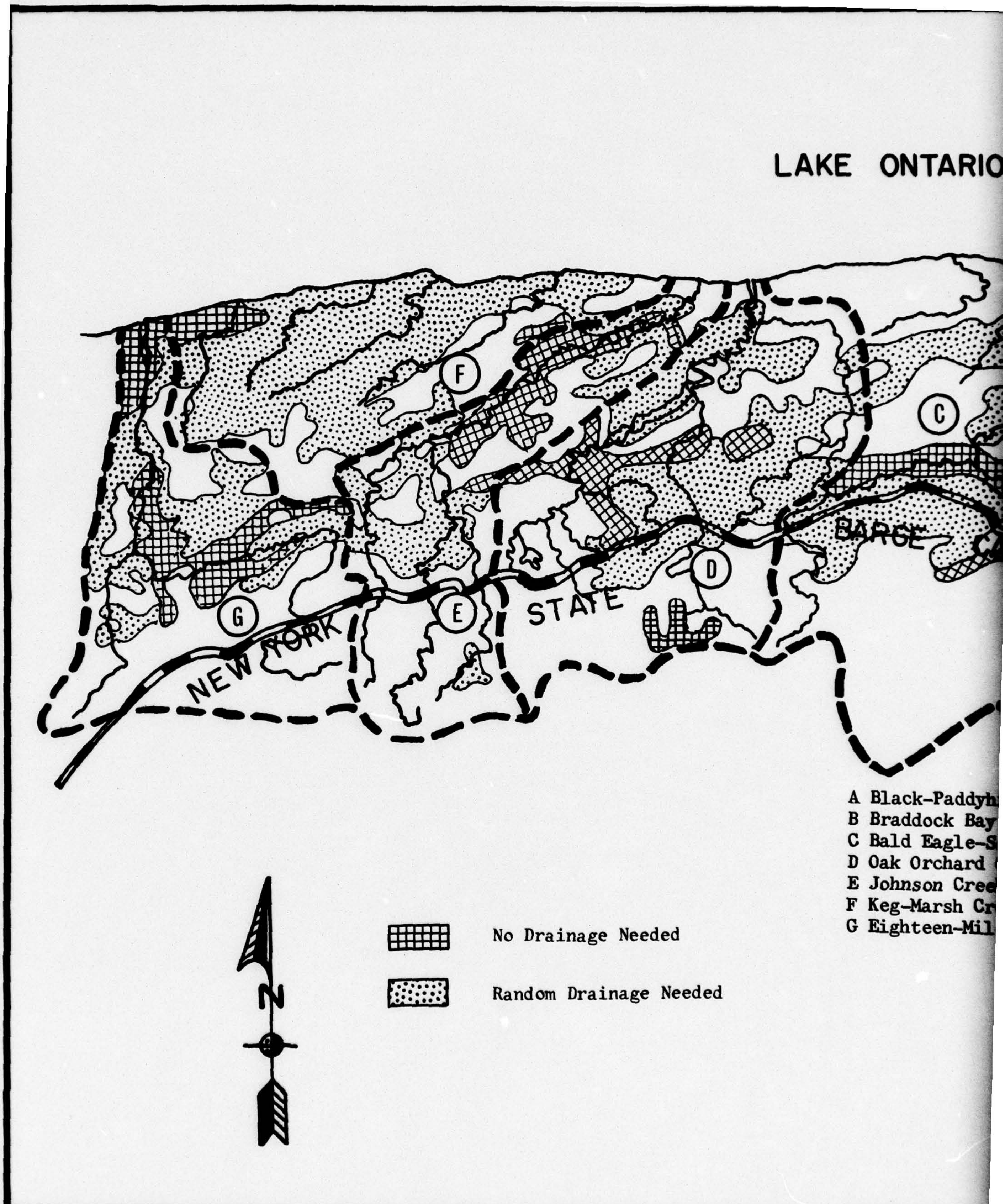
Subject to the above restrictions this report should help to indicate the potential for irrigation water use on the Ontario Lake Plains Service Area. It can locate broad areas within which local investigation should prove fruitful, but it cannot pinpoint areas which will definitely be irrigated in the future.

A description of the problems faced in each of the watersheds follows:

Watershed A - Black-Paddy Hill Creeks. Black-Paddy Hill Creeks watershed of 51,100 acres is adjacent to the city of Rochester and is currently experiencing very heavy residential pressure on its land resource. In 1959, the area had about 17,100 acres of cropland harvested of which 3,030 acres were in intensive vegetable crop production. It is expected that all land in vegetable production in ensuing years must be irrigated in order to compete effectively with other production areas. In 1959, about 460 acres were irrigated out of a total of about 13,500 acres which are suitable for irrigation.

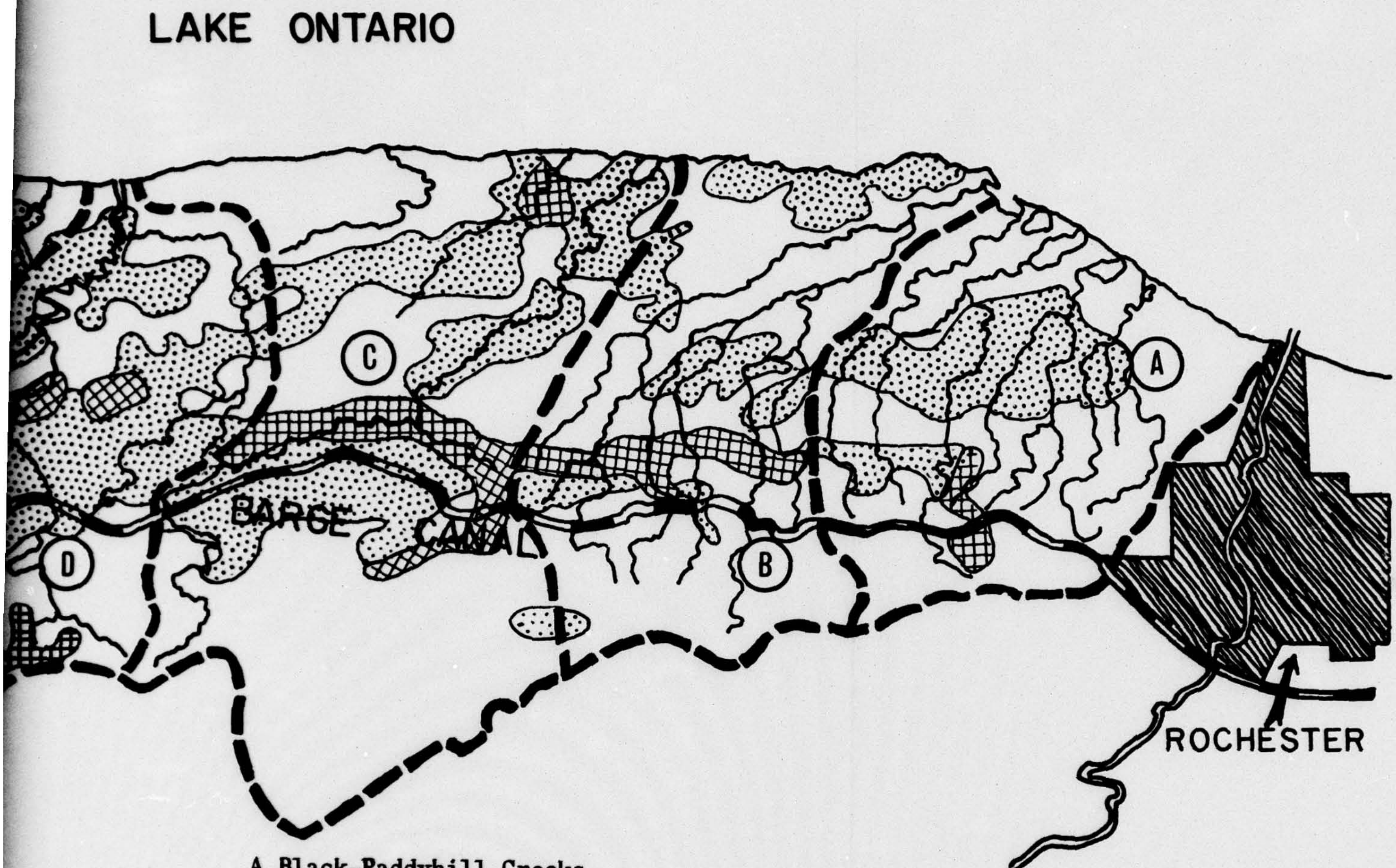
This indicates that there are about 13,040 acres of productive and potentially irrigable land in the watershed which are not now being irrigated. It further indicates that provision for irrigation water for at least 2,570 additional acres should be made by 1990 if vegetable crops are to hold their own.

Land suitable for irrigated vegetable production is also well suited and much in demand for residential construction. The fact that large quantities of less intensively used land are expected to drop out of production in the near future and be available for urban use, will lessen some of the pressure on the vegetable cropland. However, it is likely that the area will not hold its present proportion of vegetable crop production and that demands for irrigation water will not be as great as potentially possible.



LAKE ONTARIO
F
C
BARGE
D
G
E
STATE
NEW YORK
A Black-Paddyh
B Braddock Bay
C Bald Eagle-S
D Oak Orchard
E Johnson Cree
F Keg-Marsh Cr
G Eighteen-Mil
No Drainage Needed
Random Drainage Needed
N

2



A Black-Paddyhill Creeks
B Braddock Bay
C Bald Eagle-Sandy Creeks
D Oak Orchard Creek
E Johnson Creek
F Keg-Marsh Creek
G Eighteen-Mile Creek

ed

Needed

IRRIGABLE LAND

GENESEE RIVER BASIN

ONTARIO LAKE PLAINS
SERVICE AREA

JULY 1965

SCALE 1:320,000

SCALE OF MILES

5 0 5 10

Plate J26

Watershed B - Braddock Bay. The Braddock Bay watershed suffers less heavily from residential expansion than does watershed A, but experiences a similar situation with respect to its irrigation potential. Of the total 70,700 acres in the watershed, there are about 1,700 acres of land which would require no drainage in order to irrigate and about 14,320 acres which would require only random drainage. Therefore, the availability of land suitable for irrigation would not appear to be a limiting factor.

Of the 3,590 acres used for vegetable crops in 1959, only 1,270 acres were irrigated. It is projected by 1990, the remainder of the 3,590 acres or 2,320 acres will require irrigation. Additional water supplies will be needed for this area.

Watershed C - Bald Eagle, Sandy Creek. The Bald Eagle-Sandy Creek watershed is the largest of the Ontario Lake Plains Service Area watersheds with 89,000 acres. It also has the greatest quantity of irrigable land. According to the Census of Agriculture, about 5,150 acres of vegetable crops were grown in 1959. Of this total, 23 percent or 1,180 acres were irrigated. One reason for this high percentage of irrigated vegetables may be the fact that the New York State Barge Canal runs through considerable acreages of irrigable land across the entire watershed.

It is expected that by 1990, the watershed will be required to irrigate the 5,150 acres of vegetables presently grown. This results in a deficit of at least 3,970 acre feet of water annually above that which is presently being used. Since the watershed is not situated in the suburban zone of influence of any major population centers, it is not expected to suffer from excessively heavy pressure on its cropland resource and, therefore, attempts should be made to supply at least that quantity of irrigation water in the near future.

Watershed D - Oak Orchard Creek. The Oak Orchard Creek watershed is another of the larger watersheds with about 83,500 acres included in the study. The supply of land feasible to irrigate should not place any limits upon the expansion of irrigation since 30,030 acres can be irrigated either without drainage or with merely random drainage systems.

It is anticipated that a supply of irrigation water will be one of the prerequisites to continued vegetable crop production, since, of the total, about 4,730 acres were in vegetables and only 230 acres were irrigated in 1959. Expected increases in the use of irrigation for vegetable production will require the irrigation of all 4,730 acres in the future, resulting in a present deficit of about 4,500 acre feet of water annually.

Watershed E - Johnson Creek. The Johnson Creek watershed contains about 74,000 acres of land, of which 23,810 acres would be feasible to irrigate. The fact that the Barge Canal flows considerably south of the general areas of irrigable land may impose some present restrictions on the land now being irrigated. A majority of the remaining irrigable land is on small streams rather than major water courses, and this too may limit irrigation.

The Census of Agriculture indicated that 3,560 acres of vegetables were grown in 1959 and that 210 acres of crops were irrigated. Therefore, in order to irrigate the intensive vegetable crops expected to be grown in the future, provision should be made to supply the deficient 3,350 acre feet of water through some water development program.

Watershed F - Keg, Marsh Creek. The Keg and Marsh Creek watershed, totaling 55,700 acres, includes 46,780 irrigable acres or over 83 percent of its area. In 1959, only about 1,710 acres were in vegetable crops and only 200 acres were irrigated. Again, this watershed lies north of the Barge Canal and is composed of many small independent areas, so that natural surface water is not plentiful during the growing season.

The area expected to be in vegetable crop production leaves a water deficit of 1,510 acre feet annually. No urban effects which would tend to reduce the acreage in production and the resulting water deficit are in evidence at the present time.

Watershed G - Eighteen Mile Creek. The westernmost of the watersheds, Eighteen Mile Creek contains 58,400 acres, of which less than half, or 22,080 are irrigable. At this end of the lake plains, the percentage of land in vegetables has decreased to the extent that only 1,230 acres of this watershed were in intensive vegetable crop production in 1959. In that year, 270 acres were irrigated.

The irrigation of all vegetable crop acreage in the near future yields a deficit of 960 acre feet of water to be supplied annually. Because there appears to be no widespread increase in other demands for the cropland resource, it is possible that the area could increase its relative standing in national vegetable production. In that case, more water would be required than is budgeted for here.

FUTURE IRRIGATION WATER NEEDS AND THE POTENTIAL FOR MEETING THOSE NEEDS

Projected Irrigation Water Needs

As determined in the previous section on Present Irrigation Water Problems, an immediate need exists for the storage of considerable quantities of irrigation water on the Ontario Lake Plains.

Originally it was projected that at least 20 percent of all vegetables would be irrigated by 1970, 50 percent by 1980 and all vegetables by 1990. According to preliminary 1964 Census of Agriculture reports, over 20 percent were already under irrigation in 1964. This rate of increase in excess of that expected to prevail underlines the immediate nature of the problem. Table J49 shows the projected vegetable acreage, acres to be irrigated and the deficit in future supplies.

Table J49.--Projected Irrigation Water Needs1/ by Decade, Ontario Lake Plains Service Area, 1980 - 2020.

	1980	1990	2000	2010	2020
Acres in Vegetables	26,720	27,050	27,660	28,180	27,670
Acres to be Irrigated	13,360	27,050	27,660	28,180	27,670
Current Deficit in Acre Feet of Water2/	7,910	21,600	22,210	22,730	22,220

1/ One acre-foot stored for each acre to be irrigated.
2/ Deficit beyond current irrigation water available and used.

Project Formulation

In an attempt to provide for this deficit in irrigation water supply, an engineering inventory was made of all potential water impoundment sites on the Ontario Lake Plains. Those sites which appeared to be feasible from an engineering standpoint were analyzed further to determine their potential for supplying irrigation water.

Irrigation Benefit Analyses. The analysis can be broken into several sections. First the quantity of water necessary to irrigate an acre of cropland in this area was determined. Based upon antecedent soil moisture, probable rainfall and consumptive use by crops, a water budget was developed. This budget encompassed the water needed by the plant plus losses due to efficiency of application, transportation and storage. Ultimately, it was determined that about one acre-foot of water should be stored for each acre of land to be irrigated.

Next, the potential benefits due to irrigation were calculated. It was determined early in the study through the examination of partial budgets that the economic feasibility of the irrigation of crops other than vegetable and specialty crops would be doubtful. Therefore, the benefits from supplemental irrigation of a composite acre of vegetable crops were developed using projected local irrigation costs, expected yield response and projected market prices. It was determined that net benefits from the irrigation of vegetable crops in the Ontario Lake Plains would be about $21.00 per acre. This figure was used for all irrigation benefits. The

acres to be irrigated from each site were then determined. As indicated in the section on Present Land and Water Resource problems, the one limit to the total acres to be irrigated is the projected acres of vegetables in the Ontario Lake Plains. Then surrounding each site, the soil and topography placed another limitation. All areas capable of being irrigated by reason of appropriate soils and slopes were delineated on U.S. Geologic Survey maps into groups separated by drainage needs. Only those areas requiring no drainage or random drainage were considered to be economically feasible to irrigate. This is due to the high annual cost of systematic drainage systems in relation to the expected irrigation benefits. Crop rotation systems and water transportation losses limited the remaining acreage to thirty percent of the irrigable land within one-half mile of the site or stream and not more than five miles downstream. A preliminary plan was prepared for each site and costs estimated using a capacity as near to the irrigation needs as possible.

In total, twenty-nine irrigation systems capable of supplying water to about 13,000 acres of land were found to have favorable benefit-cost ratios. Several of the proposed systems had benefit-cost ratios of less than one to one but were included in the list due to the fact that a slight change in either the percent of land to be irrigated or the type of crop to be irrigated could easily render them feasible within the currently acceptable limits. The sites with engineering and economic data are shown in Tables 50 and 51.

Present irrigation water supplies plus the additional 13,000 acre feet from the proposed system could irrigate 18,000 acres annually, or about 10,000 less than the total desired. This deficit could be resolved in part through several methods. Local development of smaller sites serving one or several landowners is quite feasible in many areas. These sites are not readily apparent from the maps used in the original site inventory and will require the services of field technicians to locate. In addition, there are some surface and ground water sources which are not fully developed at present. Concentration of effort on these sources along with an integrated program of group structure development could materially diminish, if not eliminate, any future deficit in irrigation water supplies on the Ontario Lake Plains.

Legal restrictions within the State of New York currently prohibit irrigation water developments of the type designed here. Therefore, this plan carries with it the recommendation that attempts be made to resolve these legal hindrances before any detailed local planning is initiated.

<u>Engineering Procedures</u>. The procedures used to develop a structural plan in the Ontario Lake Plain differs somewhat from the procedures used for the Genesee River Basin. The principal reason for this is that only

one purpose, irrigation, was considered and water requirements were established at an early date in the study. Also, the topography and soil conditions are such that various types of structures could be considered in the plan for providing irrigation water. The following explanations describe procedures used in developing a structural plan and also describes each type of structure and irrigation system selected to furnish storage or to allow distribution of irrigation water.

1. Maps

The Ontario Lake Plain was divided into seven watershed areas which are designated A through G. Base maps were prepared and used as with the Genesee River Basin.

2. Site and Canal Selection

Tentative locations were selected for 95 reservoir sites and 19 irrigation supply canals. Each location was observed in the field and cost estimates were made on 42 reservoir sites and 8 irrigation canals which appeared to offer feasible irrigation supply.

A feasibility study was then made resulting in a final list of structures recommended for construction. These structures are listed in Tables J50 and J51 and are located on the base maps. They include 29 reservoirs and 2 irrigation canals.

Structures which are not presently feasible but which may have future potential are listed in Table J52. All structures which are recommended for construction or which may have future potential are shown on Plate J27. The watershed base maps, Plates J28 to J34 show each site in more detail including the irrigable land surrounding the site.

Sites are numbered consecutively by watersheds. As in the Genesee River Basin, the watershed in which they are located is designated by a prefix for each site.

Irrigation canals were also numbered consecutively by watersheds. They are designated by two prefixes. The first prefix is either the letter D which indicates a drainage type canal or the letters DD which indicate a diversion type canal. The letter and number following show the watershed and canal number just as the sites are designated. For instance, the first irrigation diversion canal selected in subwatershed E is numbered DD-E-1.

Table J50.--Data and Costs for Feasible Irrigation Water Storage Sites, No Channels or External Distribution Systems, Genesee River Basin - Ontario Lake Plain, 1966

Site No.	Drainage Area	Acre Feet Supplied	Height of Dam	Installa. Cost($1000)	Aver.Ann. Cost	Aver.Ann. Benefits	Benefit Cost Ratio	Remarks
B-2	0.4*	204	19	$ 76	$3,410	$4,220	1.24	-
B-7	1.0*	300	14	125	5,820	6,500	1.12	-
B-9	0.3*	190	12	98	4,100	4,120	1.00	-
B-17	1.4	340	12	116	5,950	7,370	1.24	-
B-20A	1.7	513	21	230	10,840	11,120	1.03	-
B-21	1.6	540	18	173	9,080	11,700	1.29	-
C-3	19.9	780	36	546	19,360	16,900	0.87	-
C-4	1.1	324	30	93	4,300	7,020	1.63	-
C-12	5.2	300	13	**	7,950	6,520	0.82	Enclosed Reservoir
D-6	1.7*	152	24	94	3,890	3,290	0.85	
D-7	6.4*	267	21	126	4,260	5,790	1.36	
D-12	1.1*	372	16	113	5,610	8,060	1.44	
E-4	10.2*	520	27	212	8,030	11,270	1.40	
E-6	6.2	387	29	327	11,030	8,390	0.76	
E-19	11.5	800	15	245	13,680	17,300	1.26	Enclosed Reservoir
E-20	Oak Orchard Creek	400	15	178	6,840	8,670	1.27	Enclosed Reservoir Dependent upon DD-E-2 for supply
F-5	2.3	173	20	65	3,220	3,750	1.16	
F-6	2.6	400	15	**	9,320	8,670	0.93	Enclosed Reservoir
G-3	1.1*	384	25	112	3,910	8,320	2.13	
G-4	2.5*	278	25	133	4,950	6,020	1.22	120 Ac.Ft.Supplied from NYS Barge Canal
G-6	3.6*	500	18	144	6,250	10,830	1.73	

* Signifies some additional water supplied from New York State Barge Canal.
** These sites were cost estimated from curves which did not yield this figure.

Table J51.--Data and Costs for Feasible Irrigation Systems with Channels and/or External Distribution System, Genesee River Basin - Ontario Lake Plain, 1966

Site No.	Drainage Area	Acre Feet Supplied	Height of Dam	Installation Cost Struct. ($1000)	Installation Cost Facilit. ($1000)	Aver. Ann. Cost	Aver. Ann. Benefits	Benefit Cost Ratio	Remarks
B-24	0.8	230	14	$ 90	$ 26	$6,650	$4,980	0.75	Pump System Needed
C-8A	0.8+ Sandy Cr.	519	20	169	26	10,670	11,250	1.05	Pump & Pipeline to refill site from Sandy Creek
C-11	2.9	604	33	215	32	12,870	13,090	1.02	Pump System Needed
C-13	1.0	216	14	82	103	8,100	8,100	1.00	Pump & Drainage Ditch D-C-2
D-2	9.7	1780	24	228	56				
					33	22,850	38,570	1.69	2 Pumping Systems Needed
D-4	4.7	800	20	198	79	12,470	17,330	1.39	Pump & Irrigation Ditch DD-E-2
D-8	1.1*	332	23	80	39	7,060	7,190	1.02	Pump System Needed
G-12A	1.5*	376	29	161	32	7,870	8,150	1.03	Pump System Needed

* Signifies some additional water supplied from New York State Barge Canal

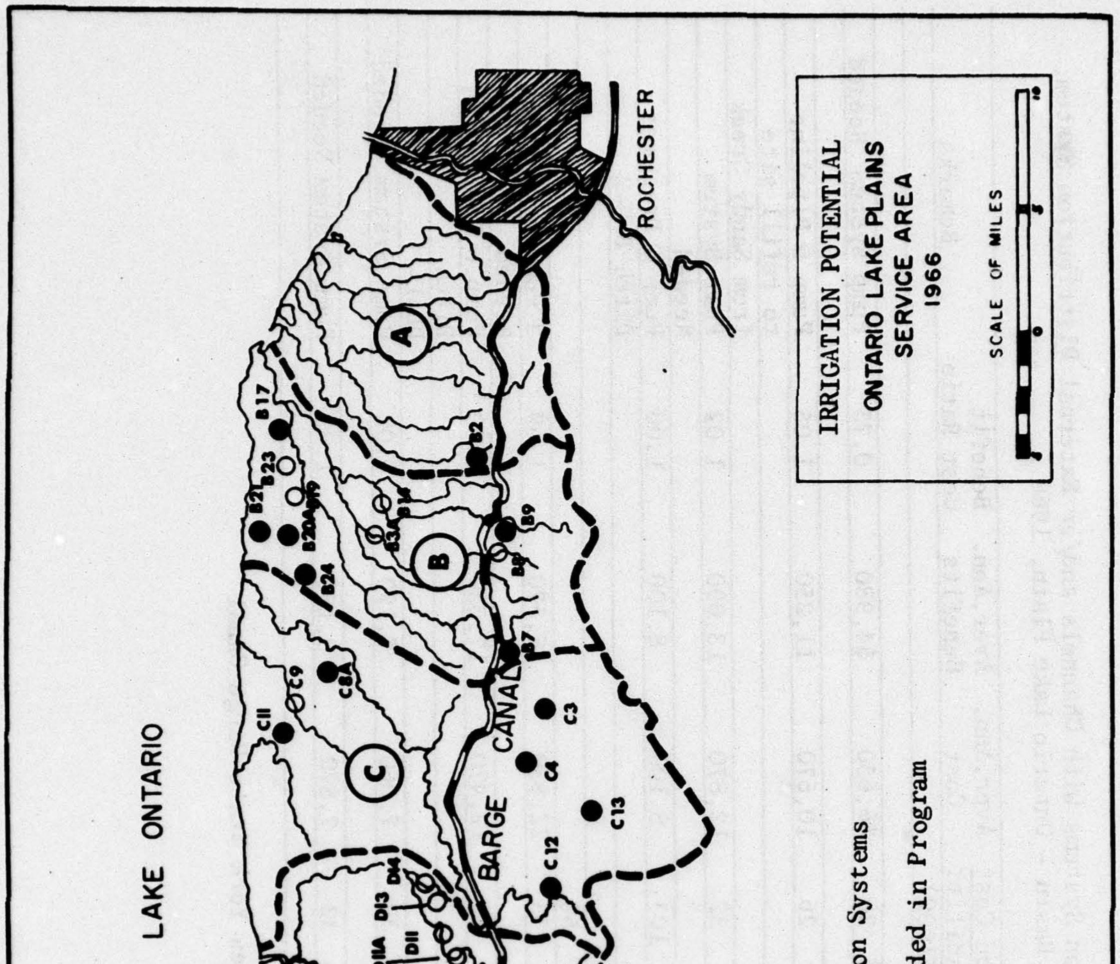

LAKE ONTARIO
IRRIGATION POTENTIAL
ONTARIO LAKE PLAINS
SERVICE AREA
1966
SCALE OF MILES
ROCHESTER
NEW YORK STATE BARGE CANAL
A
B
C
D
E
F
G
Feasible Irrigation Systems
Systems Not included in Program
N

Plate J27

Table J52.--Potential Irrigation Systems not currently justifiable, Data and Costs, Ontario Lake Plain Service Area, 1966

Site No.	Drainage Area(Sq.Mi.)	Acres to be Irrigated	Height of Dam (Ft.)	Total Installation Cost ($1,000)
B-3A	9.3*	492	30	$270
B-8	2.3*	170	16	129
B-14	7.3*	255	32	225
B-19	1.1	408	19	198
B-23	0.7	78	15	102
DD-B-1	Sandy Creek	700	-	60
C-9	0.6	85	14	93
D-11A	1.1*	243	15	161
D-13	5.8	100	21	177
D-14	2.4*	86	13	68
E-17	1.6	255	27	116
E-19	11.5	800	15	245

* Signifies some additional water supplied from New York State Barge Canal.

3. Surveys

Engineering field surveys were made to obtain embankment centerlines on the more promising structure sites and irrigation canals. Topographic surveys were made to obtain stage storage data on sites which had peculiar storage conditions. Some topographic surveys were also made for comparison with the U. S. Geological Survey maps. Aerial photos were used to aid in making surveys. Several photos were used to prepare enlargements of the pool areas surveyed. Topographic information was then plotted on the photo enlargements. These aerial photo enlargements were used for sites B-3A, B-4 and C-3.

Channel cross sections were taken on existing streams to determine channel capacities below structure sites.

Sections were also taken along the proposed irrigation canal centerlines to estimate excavation for cost analysis.

4. Design Criteria

Design criteria conforms to Soil Conservation Service Standards and Specifications. Generalized hydrologic and structural design criteria were used in planning and estimating the cost of all developments. The design and analysis of any work plan type report will require more specific criteria and detailed data on conditions prevailing at each particular location.

5. Cost Estimates

Design and cost estimates were made on those sites and canals which appeared to be feasible. See Tables J50, J51, and J52 for a list of those for which cost estimates were made.

Unit costs were obtained from local SCS technicians, records of PL-566 contracts, local equipment companies, and local highway and utility representatives.

Total installation cost of each structure includes construction cost plus contingencies, engineering services, land, buildings, utilities, road relocations and administration of contracts.

Operation and maintenance costs were also considered in determining what selected structures would be feasible.

6. Geology

Most of the geology information was interpreted from the county soils maps. Where significant geologic problems were noticed, proper consideration was given in site selection and cost estimates. Any further planning must include a more thorough geologic investigation.

7. Types of Structures Considered

The following explanations are given to describe the various types of structures selected for the storage and distribution of irrigation water in the Ontario Lake Plain. All designs conform to Soil Conservation Service standards and specifications when applicable.

a. Impoundment Sites - An impoundment site is considered to be a structure which is constructed across natural stream causing water to be impounded.

The proposed impoundment structures in the Ontario Lake Plain are of the same type as the structure sites studied in the Genesee River Basin. Therefore, design and cost criteria are much the same as described in the procedures for the Genesee River Basin.

The irrigation storage was fixed by a generalized relationship of the ultimate storage potential and the total demand of the area within reasonable distance of the site.

Factors affecting the total selected irrigation storage were, (1) topographic features and limits, (2) irrigation demand (normally up to 5 miles downstream from the site), and (3) water yield from the drainage area and outside sources such as the New York State Barge Canal.

Impoundment structures are normally the least expensive method of storing water. However, topography is sometimes too flat to allow this type of storage. Twenty-two impoundment sites are included in the final structural plan for the Ontario Lake Plain.

b. Enclosed Reservoir Sites - An enclosed reservoir is a structure constructed on a relatively flat area of impervious soil. It is entirely enclosed on all sides by a constructed levee which usually forms the shape of a rectangle. The reservoir is supplied from a dependable outside source, usually a natural stream from which the water is pumped.

The total storage of each reservoir would be dependent upon the irrigation demand and the water yield of the supply stream. Irrigation water would be released by gravity through turnouts which consist of treated metal pipes with gates.

The enclosed reservoir has been selected to provide irrigation storage where the land is too flat for impoundment structures. An enclosed structure, however, is usually too expensive to provide irrigation storage for areas less than 200 acres in size.

Enclosed reservoirs which are considered feasible and are included in the structural plan are sites C-12, C-13, E-19, E-20, and F-6.

c. Depression Sites - A depression site is a depression in the normal ground which is located on the upstream side of a levee of the New York State Barge Canal. The depressions are areas from which borrow material was taken to construct the Barge Canal levees. These sites can be supplied from natural runoff as well as from the Barge Canal. The designs are computed the same way as for impoundment sites.

For this study, it is assumed that entirely new earth embankments would be constructed to add additional permanent and flood storage to the depression volume. It may prove possible in later studies to utilize the existing canal levee thereby reducing the volume of fill required.

Depression sites are designed to use the existing drainage conduit which now conveys runoff under the canal. This conduit would provide release for floodwater and irrigation water.

A pipeline is designed to deliver water for storage from the Barge Canal to the reservoir.

There are many other depression areas along the Barge Canal which have not been included in the structural plan. Future studies may more firmly establish the ability of the existing upstream canal levee to be used as a reservoir embankment with some slight modifications. If such findings were made which resulted in lower cost estimates, then, more such storage areas would be feasible for development.

The depression structures included in the structural plan are sites B-7 and B-9.

d. Irrigation canals - Irrigation canals were designed to convey irrigation water from the source to either an irrigable area, or a reservoir, or both. The canal may be supplied by direct diversion or pumping.

The two types of irrigation canals considered in the structural plan are (1) those which convey water from one watershed to another and (2) those which provide for drainage as well as irrigation and are located in one watershed.

Of the two types of channels included in the structural plan, DD-E-2 is a diversion type canal and D-C-2 is designed for drainage and irrigation.

Depending on the purpose, an irrigation ditch with its pump and pipeline system is designed to deliver water at a rate based on 10 gallons per minute per acre irrigated, or a reasonable time to fill an irrigation reservoir, or the required drainage capacity.

Channels are designed to carry the required capacity at non-eroding velocities. To prevent excessive seepage, some ditches are designed to be lined with impervious material through areas of pervious soils. A diversion structure is usually required to divert water from the natural stream into the irrigation ditch, to back water up a channel for irrigation pumping, or to provide a sump pool for a pump. An underground pipeline can be used to convey from the pump to an outlet in the irrigation ditch.

e. Irrigation Distribution - The irrigation distribution considered in plan formulation involves the transfer of irrigation water from a point of supply, such as a reservoir, canal, or stream to a point of distribution within an irrigable area. The purpose of this distribution is to irrigate large areas which are such a distance away from the water supply that they cannot be irrigated with normal type farm irrigation equipment. It is assumed that all large irrigable areas over 1/2 mile from a point of supply will require this distribution system.

The method of delivery is to pump through an underground pipeline to the point of distribution. A pumping station would be located at the water source with the necessary structure to provide a sump pool for the pump. The underground pipeline would deliver the water to the distribution point supplying two or more landowners. The landowners would connect directly on to the main pipeline with their pipelines and booster pumps or they may pump from a small storage pond which could be constructed at the end of the underground main.

Total pumping requirements are based on a peak capacity of 7 gallons per minute per acre irrigated and on an annual delivery of 6 acre-inches per acre.

Structural Plan. A study was made initially of present sources of irrigation water and the present methods of utilizing these sources. It was found that various structural measures could be designed to more efficiently use this available water. In other words, if the present water supply of the Ontario Lake Plain were efficiently distributed and adequately stored during periods of high runoff, the result would be a great increase in the number of acres irrigated.

At the present time most of the natural runoff, in the form of rainfall and snowmelt, is passing through the streams and into Lake Ontario during the non-growing season. Therefore the only stream flow available for irrigation is that which is flowing during the irrigating season when some streams are dry and others are at their lowest capacity. Large streams which have a dependable flow during the summer months, offer this supply to riparian acreage.

The New York State Barge Canal is presently providing some irrigation water by metered siphons. This diversion of water from the canal is governed by New York State law and requires permits for any water use. It was observed that much of this water was being lost by passing downstream when farmers were not irrigating. This available supply in the canal is also not being siphoned out during the non-irrigating season.

This structural plan is an effort to show the possibilities of constructing storage reservoirs for the collection and regulated release of runoff; of constructing irrigation canals, pumps, and pipelines to deliver and distribute water from streams and/or reservoirs, and of constructing reservoirs to store water from the Barge Canal whenever it is available for release.

It must be recognized that this plan attempts to provide irrigation water for as many irrigable acres as possible without consideration for existing laws and regulations. It also is evident that some of the structures recommended could not be allowed under existing laws. An example would be irrigation diversion canal DD-E-2, which delivers water from one watershed to another.

In this study, all of the seven watersheds were found to present opportunities for development under Public Law 566 - the Watershed Protection and Flood Prevention Act, as amended. Under this act, these watersheds may be developed if sponsored by qualified local groups. Discussed below is the structural plan for each watershed. The site locations are depicted on Plates J27 through J34 while structural design and cost data are presented in Tables J50 and J51.

Watershed A - Watershed A is so rapidly becoming urbanized that only a few reservoir sites were considered to have potential for irrigation supply. These sites were numbered with the prefix B and became a part of the structural plan for subwatershed B. Only site B-2 was determined to be economically feasible. It supplies water to irrigate 200 acres.

Watershed B - The structural plan for watershed B consists of 7 irrigation reservoirs all in Monroe County. They supply irrigation water for about 2100 acres.

Sites B-7 and B-9 are small depression structures which depend upon the Barge Canal to supply a portion of the total storage they contain.

Sites B-17, B-20A, B-21, and B-24 are impoundment structures which depend solely on the runoff from each particular drainage area.

There is a possibility of pumping additional water from Sandy Creek to provide supplemental storage for these impoundment sites. This supplemental supply might be desirable during dry years when the

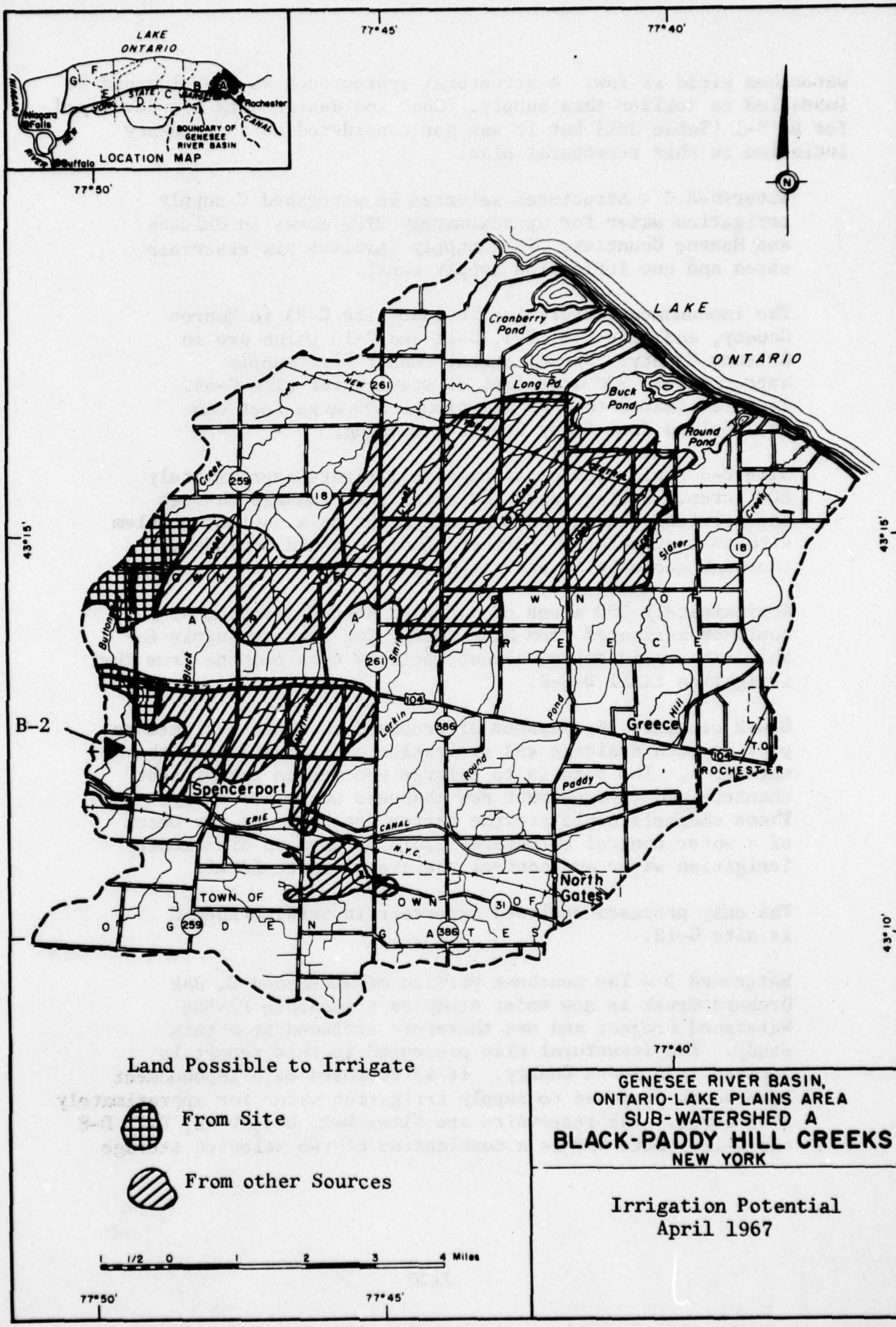

LAKE
ONTARIO
LOCATION MAP
Rochester
Niagara Falls
Buffalo
BOUNDARY OF GENESEE RIVER BASIN
CANAL
77°50'
77°45'
77°40'
43°15'
43°10'
LAKE
ONTARIO
Cranberry Pond
Long Pd
Buck Pond
Round Pond
Greece
Spencerport
North Gates
ROCHESTER
B-2
TOWN OF
OGDEN
TOWN OF GATES
TOWN OF GREECE
ERIE
CANAL
N.Y.C.
Land Possible to Irrigate
From Site
From other Sources
1/2 0 1 2 3 4 Miles
GENESEE RIVER BASIN,
ONTARIO-LAKE PLAINS AREA
SUB-WATERSHED A
BLACK-PADDY HILL CREEKS
NEW YORK
Irrigation Potential
April 1967

Plate J28

watershed yield is low. A structural system such as DD-B-1 could be installed to deliver this supply. Cost and design data are developed for DD-B-1 (Table J51) but it was not considered as a necessary inclusion in this structural plan.

Watershed C - Structures selected in watershed C supply irrigation water for approximately 2700 acres in Orleans and Monroe Counties. This supply involves six reservoir sites and one irrigation supply canal.

The impoundment reservoirs include site C-8A in Monroe County, and site C-3, C-4, C-11 and C-13 which are in Orleans County. Normal annual runoff will supply approximately 300 acre feet of storage for site C-8A. It is estimated that an additional 200 acre feet can be supplied from Sandy Creek by pumping.

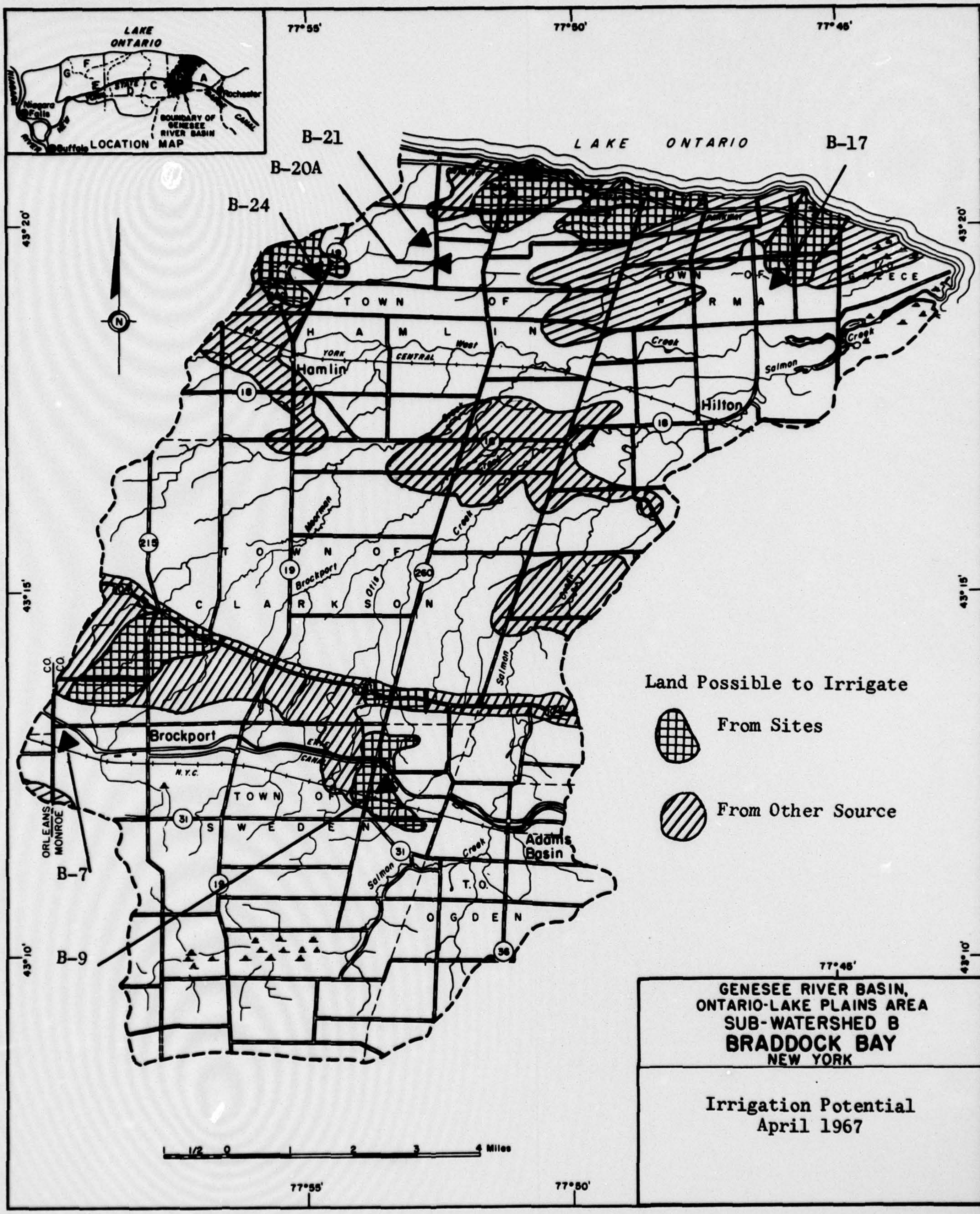
Site C-3 could provide storage to irrigate approximately 800 acres. Geology data indicates that leakage through the pervious foundation material might be a serious problem with this structure. Further studies should include a thorough geologic investigation.

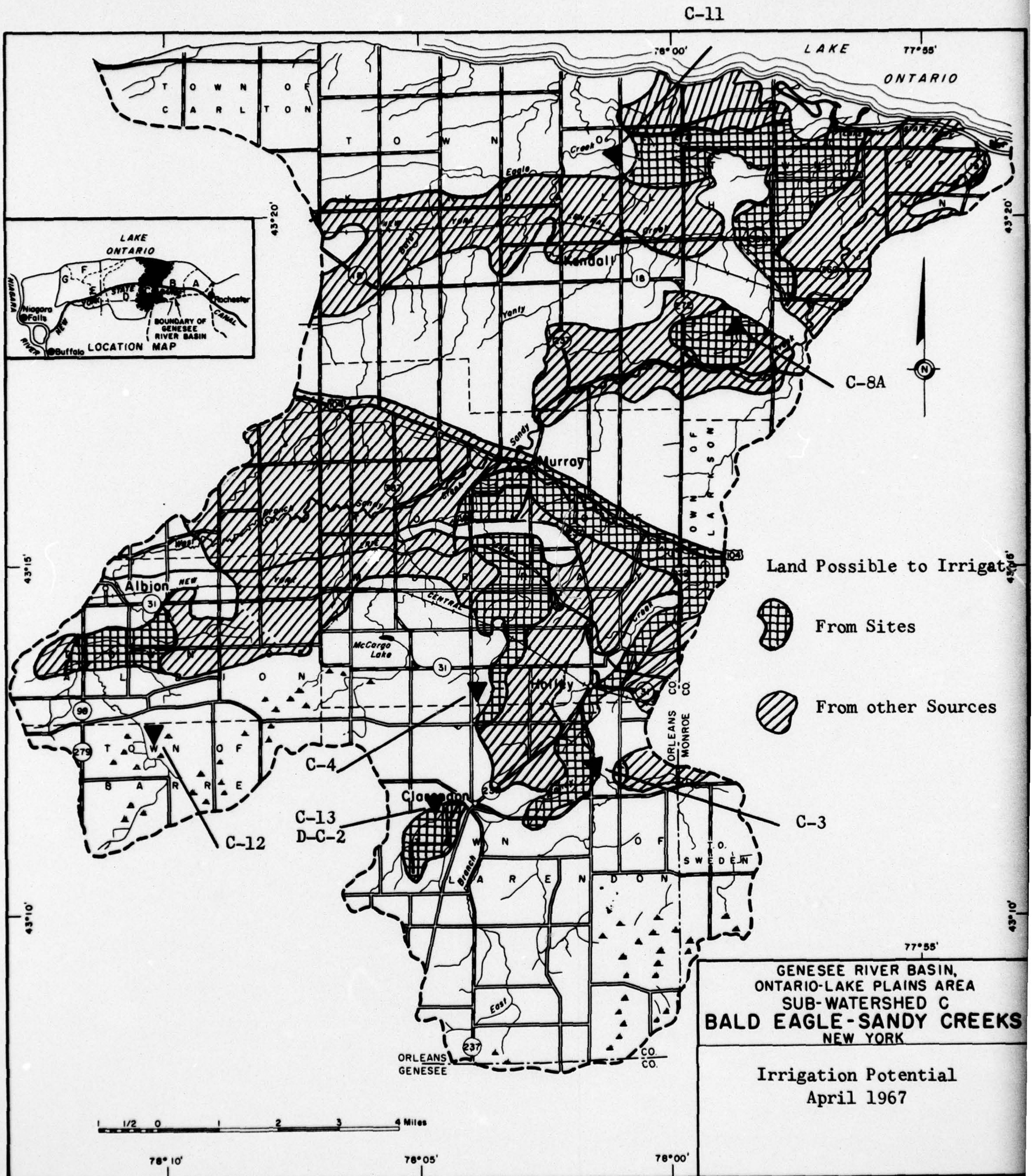
Approximately 200 acres of muckland near Clarendon, N. Y. could be irrigated from Site C-13. The storage supply for this site would depend almost entirely upon pumping from the irrigation canal D-C-2.

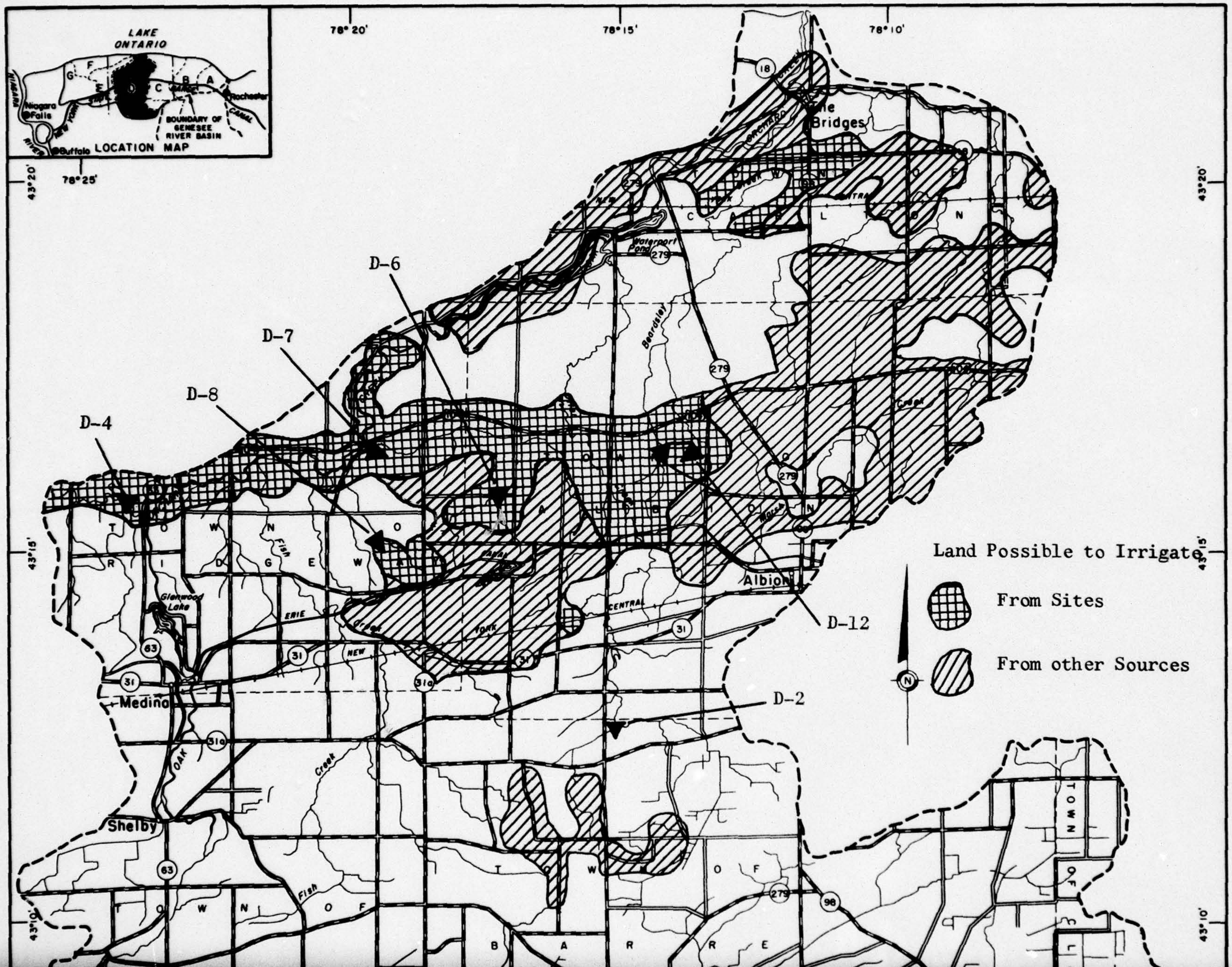
D-C-2 consists of a system of proposed channels designed to provide both drainage and irrigation distribution for the muck area. The plan is to enlarge and deepen the present channels and to construct new channels where necessary. These channels would provide better drainage and, by means of a water control structure, could be used to distribute irrigation water and control the ground water level.

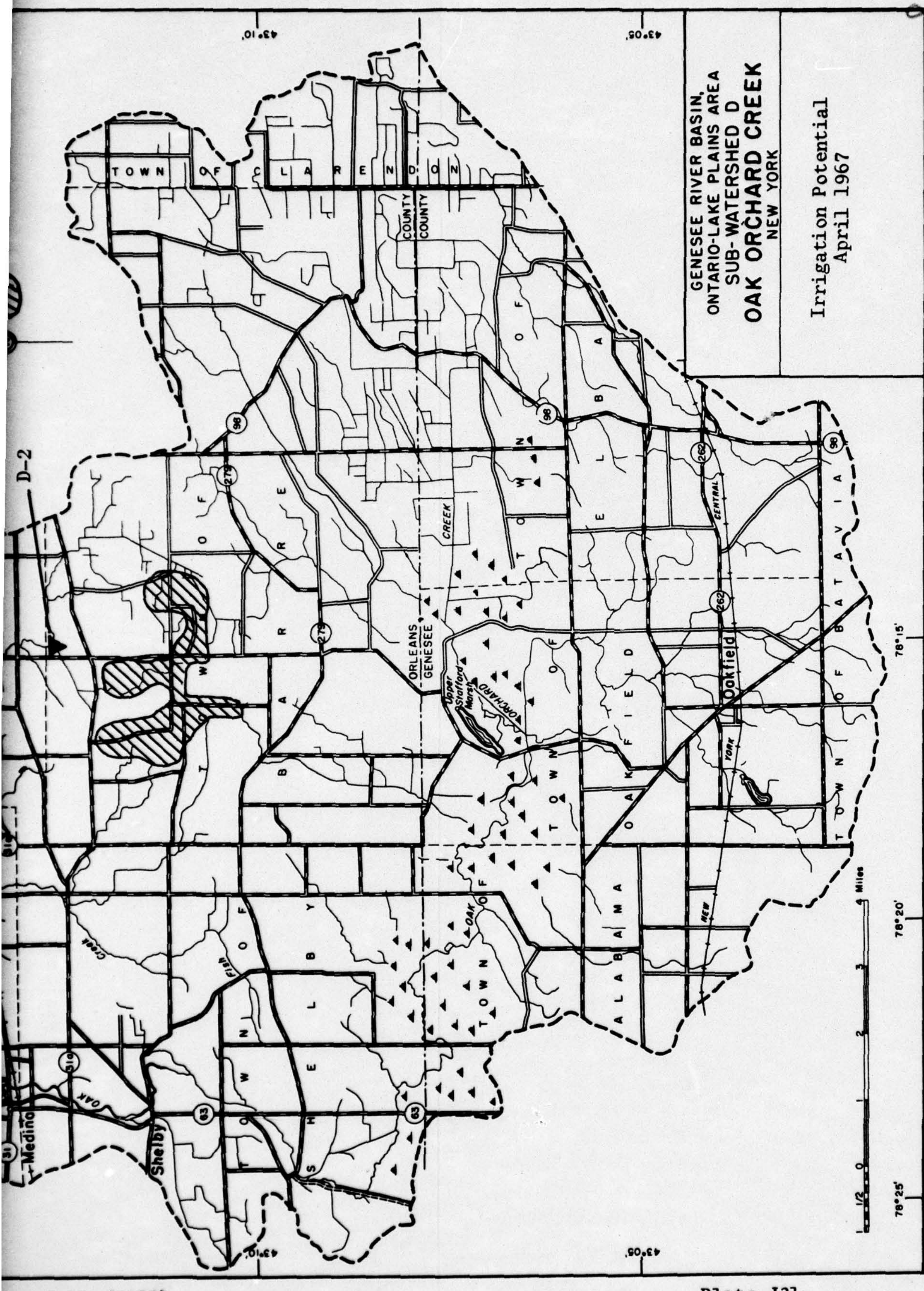
The only proposed enclosed reservoir in subwatershed C is site C-12.

Watershed D - The southern portion of watershed D, Oak Orchard Creek is now under study as a possible Pl-566 Watershed Project and was therefore excluded from this study. The structural plan presented in this report is located in Orleans County. It is composed of 6 impoundment reservoirs proposed to supply irrigation water for approximately 3700 acres. The reservoirs are Sites D-2, D-4, D- 6, D-7, D-8 and D-12. Site D-2 is a combination of two selected storage


LAKE ONTARIO
LOCATION MAP
LAKE ONTARIO
B-21
B-20A
B-24
B-17
TOWN OF HAMLIN
TOWN OF PARMA
Hamlin
Hilton
TOWN OF CLARKSON
Brockport
TOWN OF SWEDEN
T. O. OGDEN
Adams Basin
B-7
B-9
ORLEANS
MONROE
77°55'
77°50'
77°45'
43°20'
43°15'
43°10'
Land Possible to Irrigate
From Sites
From Other Source
GENESEE RIVER BASIN,
ONTARIO-LAKE PLAINS AREA
SUB-WATERSHED B
BRADDOCK BAY
NEW YORK
Irrigation Potential
April 1967
4 Miles


C-11
LAKE ONTARIO
TOWN OF CARLTON
LAKE ONTARIO
LOCATION MAP
Niagara Falls
Buffalo
Rochester
BOUNDARY OF GENESEE RIVER BASIN
Kendall
Murray
Albion
McCargo Lake
Holley
Clarendon
C-8A
C-4
C-13
D-C-2
C-12
C-3
ORLEANS
MONROE
ORLEANS
GENESEE
Land Possible to Irrigate
From Sites
From other Sources
GENESEE RIVER BASIN,
ONTARIO-LAKE PLAINS AREA
SUB-WATERSHED C
BALD EAGLE-SANDY CREEKS
NEW YORK
Irrigation Potential
April 1967
4 Miles


LAKE ONTARIO
Niagara Falls
Buffalo
Rochester
BOUNDARY OF GENESEE RIVER BASIN
LOCATION MAP
78° 25'
78° 20'
78° 15'
78° 10'
43° 20'
43° 15'
43° 10'
D-6
D-7
D-8
D-4
D-12
D-2
Bridges
Waterport Pond
Beardsley
Albion
Medina
Shelby
Glenwood Lake
Fish
Creek
ERIE
NEW
YORK
CENTRAL
OAK
Land Possible to Irrigate
From Sites
From other Sources



J175 (J176)

Plate J31

areas, sites D-2 and D-2A. It is one of the largest reservoirs selected in the Ontario Lake Plain and contains storage of 1780 acre-feet. The water released from Site D-2 into Otter Creek would provide water for 600 acres. Two pumping stations located 3 and 4 miles downstream from the site would supply 800 acres and 380 acres respectively. These pumping stations will divert water from Otter Creek into smaller streams which pass through other irrigable areas.

Storage in Site D-4 supplies irrigation water for 200 acres surrounding the site and for 600 acres located in watershed E. The supply for the watershed E area is released into Oak Orchard Creek, picked up by a pump approximately a mile downstream from the site, and delivered across U.S. Highway 104 through a pipeline and into a channel. The pump, pipeline, and channel system is designated DD-E-2. A short diversion canal just north of West Road is planned to divert a small stream which will provide additional runoff for Site D-4.

The area supplied by Site D-8 is located upstream and a pumping system will be necessary to deliver the water from the reservoir to most of the irrigated area.

Watershed E - The structural plan for watershed E includes 4 reservoirs and one irrigation supply canal; all of which contribute to the planned irrigation of approximately 2100 acres. Site E-19, an enclosed reservoir, is located in Niagara County. Impoundment Sites E-4 and E-6, enclosed reservoir E-20, and irrigation canal DD-E-2, are in Orleans County.

Site E-4 is a proposed impoundment reservoir on Jiddo Creek. Approximately half of its 520 acre-feet of storage will have to be delivered to the west by a pumping system.

Site 19, an enclosed reservoir, is designed to obtain water by pumping from Johnson Creek during periods of high water and release the same water back into Johnson Creek when it is needed for irrigation.

Site 20, also an enclosed reservoir, can be supplied by the pump and pipeline of DD-E-2 which, during high flow would obtain water from Oak Orchard Creek in watershed D.

The irrigation canal system DD-E-2 would deliver water from subwatershed D to subwatershed E for two separate purposes. Its primary purpose, during the irrigating season, would be to deliver the water released by Site D-4, to the irrigable

area in subwatershed E. The other purpose is to supply Site E-20 from the excess water of Oak Orchard Creek during periods of high flows at any time of the year.

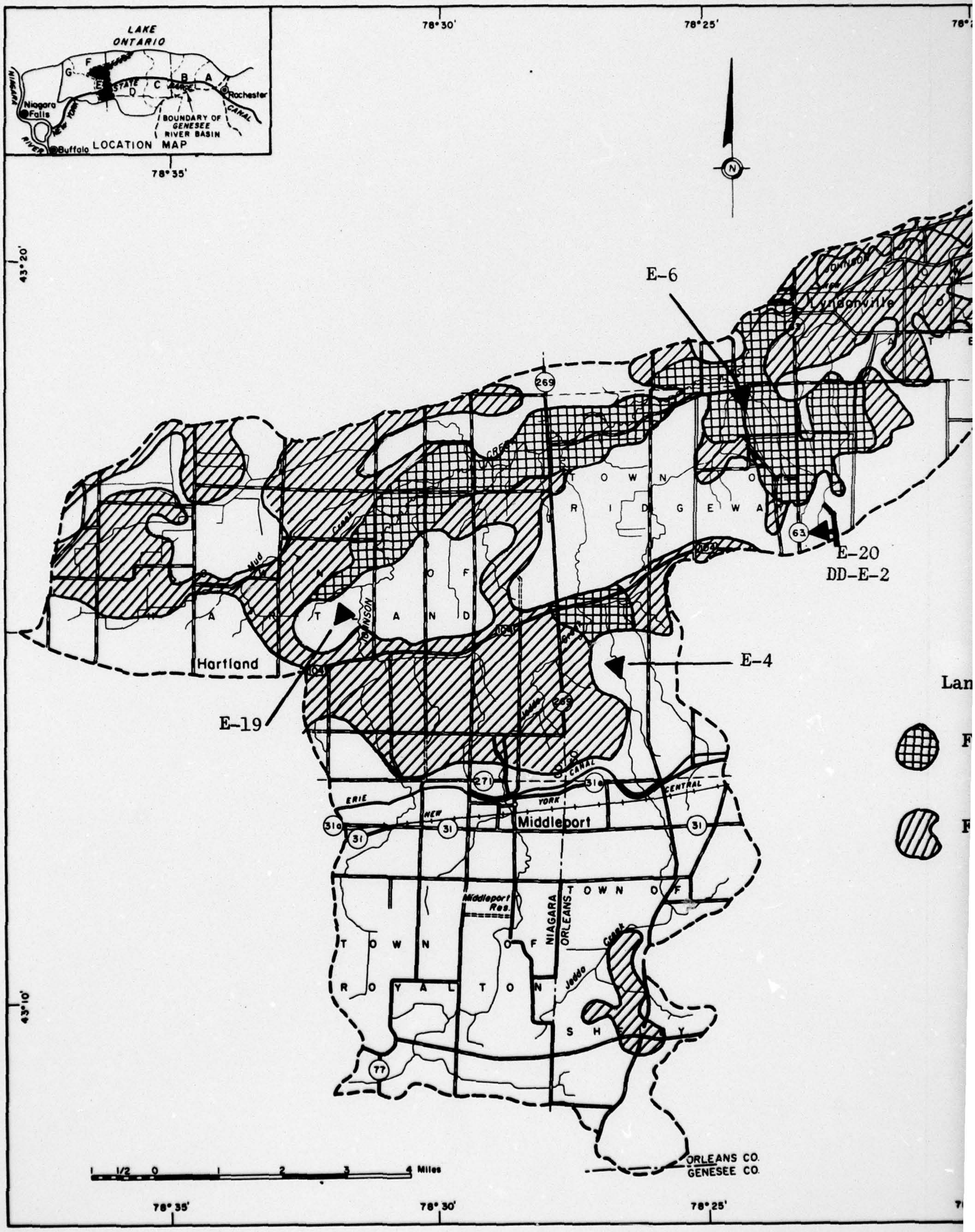
The system proposed for DD-E-2 consists of a pumping station at Oak Orchard Creek, approximately 1600 feet of 16 inch underground pipeline 1/4 mile of channel with impervious lining, and 3/4 mile of earth channel. This system would carry water across U.S. Highway 104 and into a natural stream which flows through the area to be irrigated. A gated lateral pipeline would connect the large pipeline to Site E-20. Thus, water could be supplied to Site E-20.

Watershed F - Two reservoirs are planned to irrigate approximately 600 acre feet, all of which is in Niagara County.

Site F-5 is an impoundment structure and Site F-6 is an enclosed reservoir. Both sites are on tributaries to Golden Hill Creek.

Watershed G - Impoundment Sites G-3, G-4, G-6 and G-12A compose the structural plan for watershed G and are all located in Niagara County. All of the sites are tributaries to East Branch Eighteenmile Creek and would irrigate a total of 1500 acres. The Barge Canal could contribute to the storage of all the sites if needed; however, it is only considered necessary as a supplemental supply for site G-4.

One downstream pumping plant is planned to fully utilize the storage in Site 12A. This distribution system would supply about 200 nonriparian acres.


LAKE
ONTARIO
Niagara Falls
Buffalo
Rochester
BOUNDARY OF GENESEE RIVER BASIN
LOCATION MAP
78°35'
78°30'
78°25'
43°20'
43°10'
E-6
Lyndonville
E-20
DD-E-2
E-4
E-19
Hartland
Middleport
Middleport Res.
NIAGARA
ORLEANS
ORLEANS CO.
GENESEE CO.
1 1/2 0 1 2 3 4 Miles

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GENESEE RIVER BASIN COMPREHENSIVE STUDY OF WATER AND RELATED LA--ETC(U)
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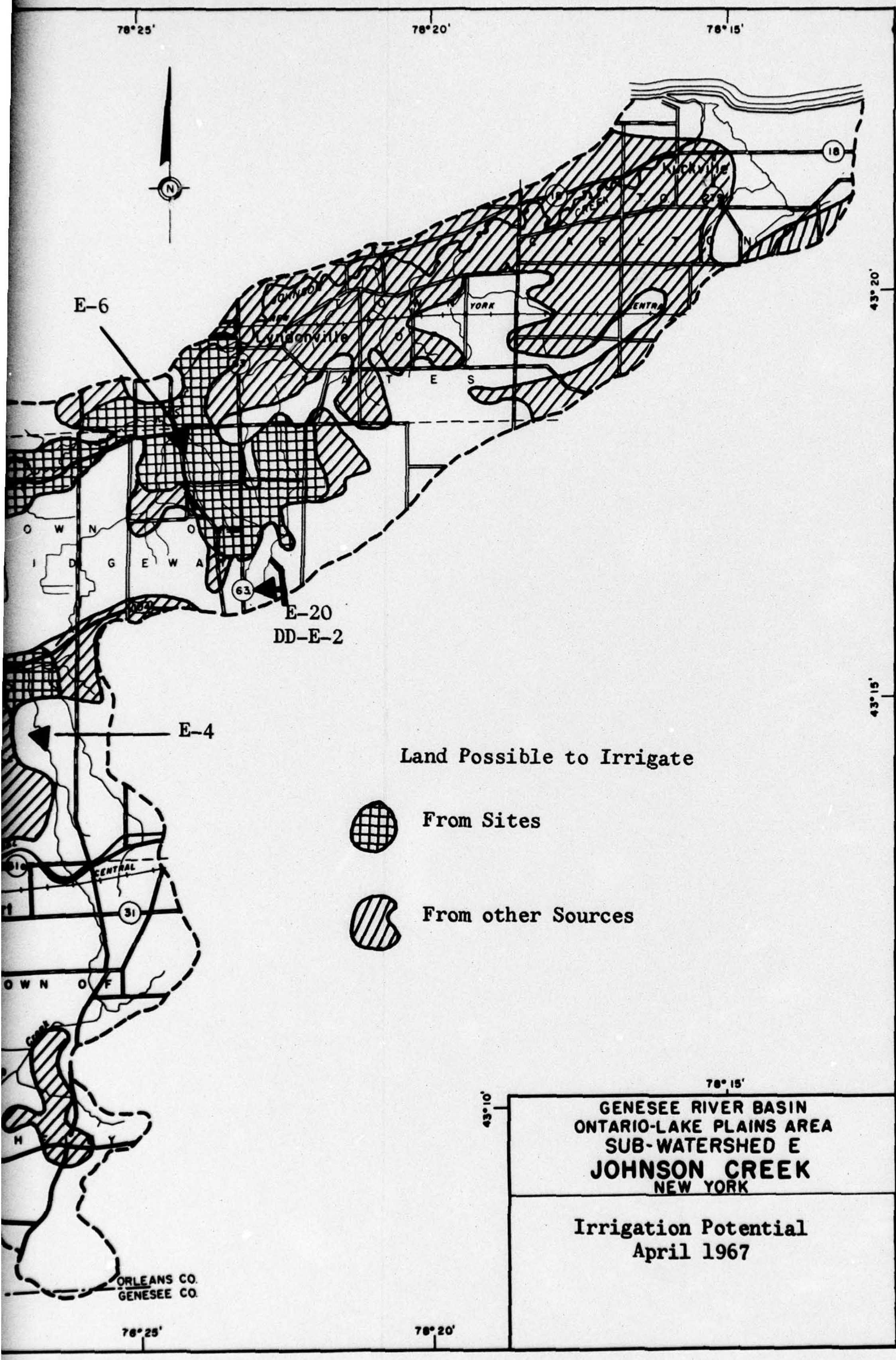


78°25'
78°20'
78°15'
43°20'
43°15'
43°10'
E-6
E-20
DD-E-2
E-4
63
18
31
ORLEANS CO.
GENESEE CO.
Land Possible to Irrigate
From Sites
From other Sources
GENESEE RIVER BASIN
ONTARIO-LAKE PLAINS AREA
SUB-WATERSHED E
JOHNSON CREEK
NEW YORK
Irrigation Potential
April 1967

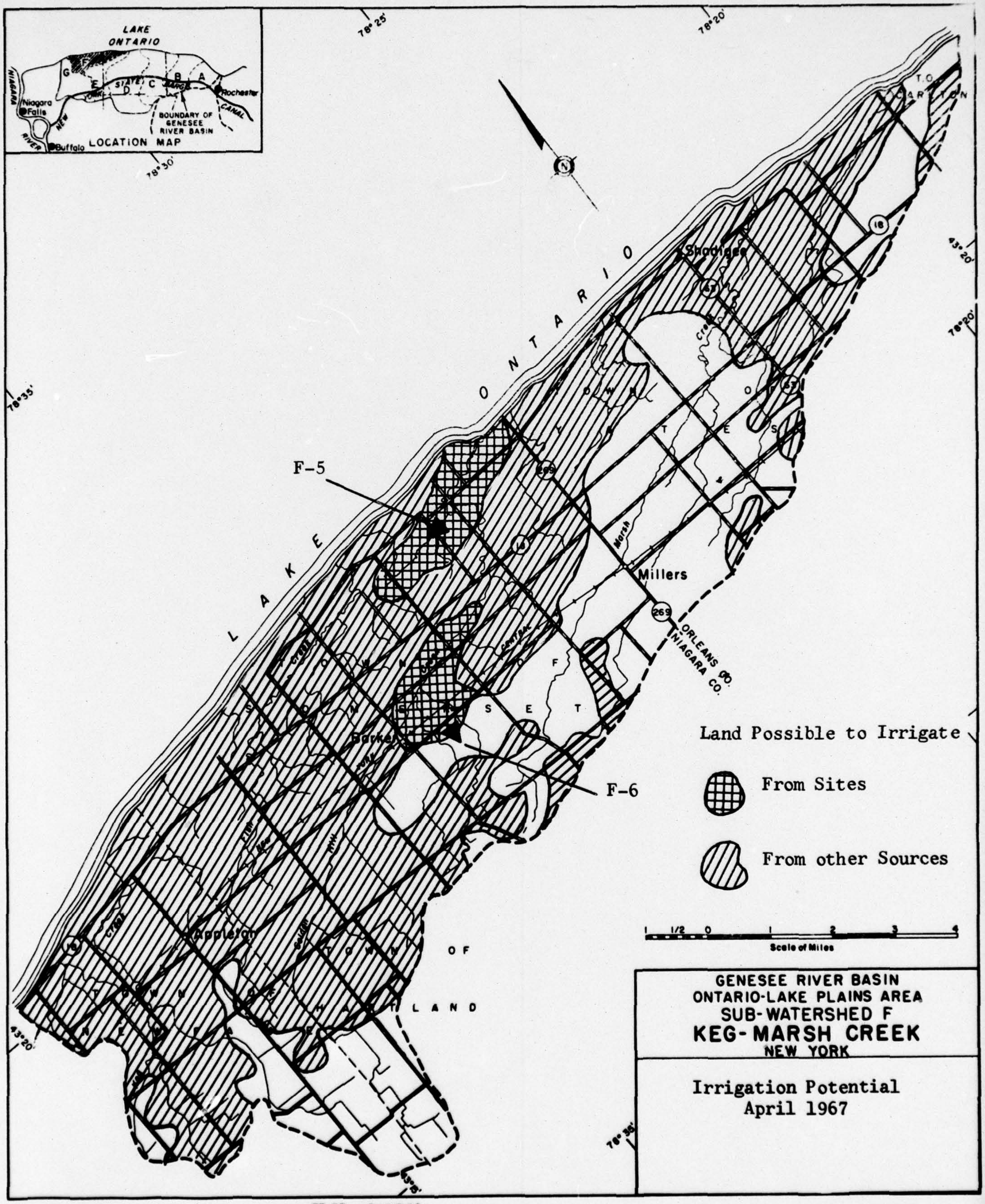
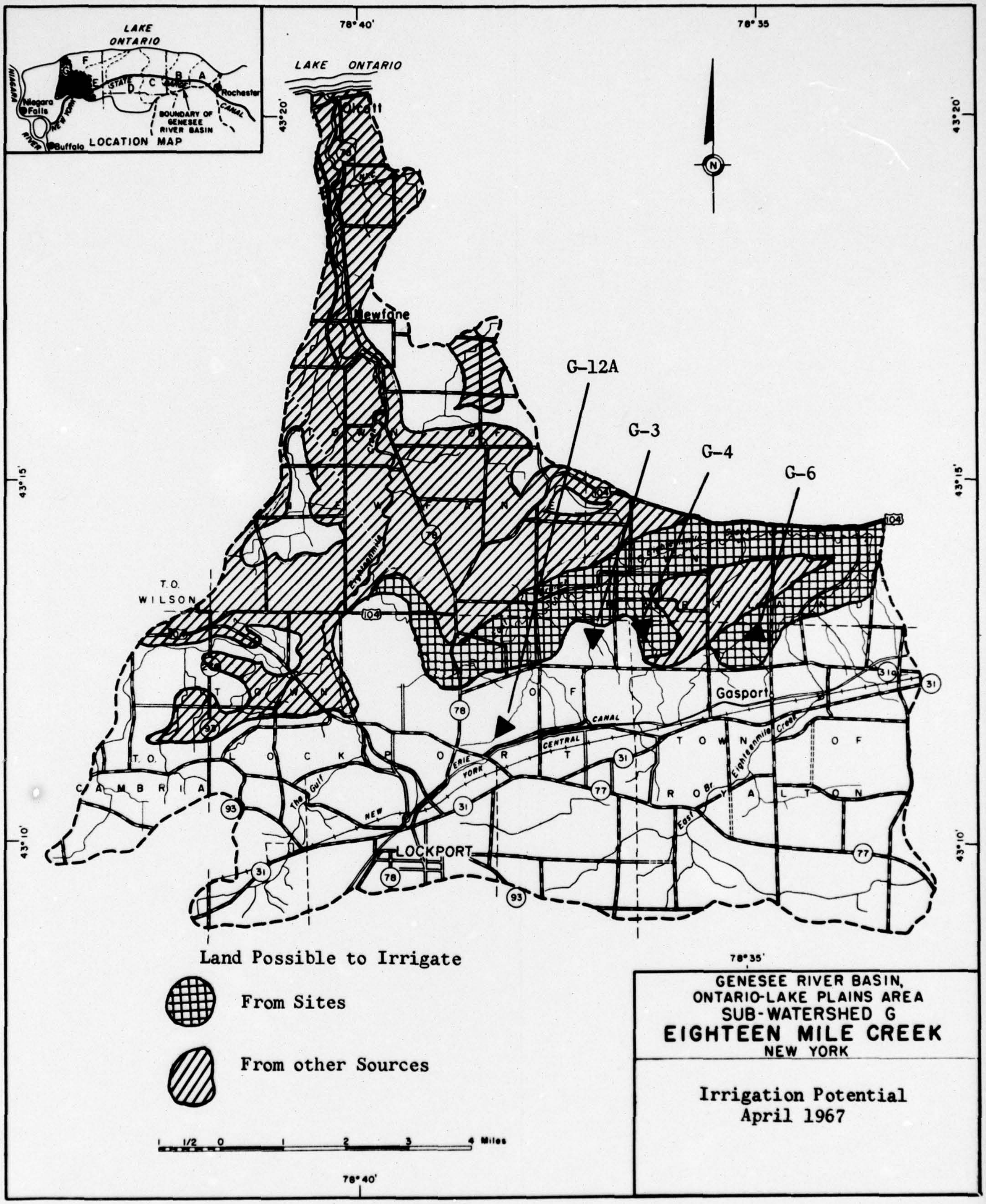

LAKE ONTARIO
LOCATION MAP
BOUNDARY OF GENESEE RIVER BASIN
Rochester
Niagara Falls
Buffalo
LAKE ONTARIO
F-5
F-6
Millers
Shadigee
Appleton
Barker
ORLEANS CO.
NIAGARA CO.
Land Possible to Irrigate
From Sites
From other Sources
Scale of Miles
GENESEE RIVER BASIN
ONTARIO-LAKE PLAINS AREA
SUB-WATERSHED F
KEG-MARSH CREEK
NEW YORK
Irrigation Potential
April 1967

Plate J33



LAKE ONTARIO
LOCATION MAP
Niagara Falls
Buffalo
Rochester
BOUNDARY OF GENESEE RIVER BASIN
78° 40'
78° 35
43° 20'
43° 15'
43° 10'
LAKE ONTARIO
Olcott
Newfane
G-12A
G-3
G-4
G-6
T.O. WILSON
Gasport
CANAL
CENTRAL
LOCKPORT
T.O. CAMBRIA
LOCKPORT
ROYALTON
Eighteenmile Creek
The Gulf
78°35'
Land Possible to Irrigate
From Sites
From other Sources
1/2 0 1 2 3 4 Miles
78° 40'
GENESEE RIVER BASIN,
ONTARIO-LAKE PLAINS AREA
SUB-WATERSHED G
EIGHTEEN MILE CREEK
NEW YORK
Irrigation Potential
April 1967

Table J-A1 - Commercial and non-commercial forest land in the Genesee River Basin, by Economic Sub-region and County, 1966

County & Sub-region	Commercial Forest	Non-Commercial	Total Forest	Non-Forest	All Land	Percent of Commercial Forest
	- - - - - - - -	- - - - - - - -	- - - - Acres	- - - - - - - -	- - - - - - - -	- - - - - - - -
Barge Canal						
Monroe	34,700	--	34,700	396,000	430,700	8.1
Orleans	21,500	--	21,500	231,900	253,400	8.5
Wayne	114,300	--	114,300	274,200	388,500	29.0
Sub-total	170,500	--	170,500	902,100	1,072,600	15.9
Central Plains						
Genesee	57,900	--	57,900	262,800	320,700	18.1
Livingston	64,900	--	64,900	343,400	408,300	15.9
Ontario	77,300	--	77,300	358,100	415,400	18.6
Wyoming	85,700	--	85,700	297,000	382,700	22.4
Sub-total	285,800	--	285,800	1,241,300	1,527,100	18.7
Allegheny Plateau						
Allegany	248,200	--	248,200	422,500	670,700	37.0
Cattaraugus	368,000	57,800	425,800	428,600	854,400	43.1
Steuben	366,900	--	366,900	536,100	901,000	40.7
Potter (Pa.)	559,600	200	559,800	139,100	698,900	80.1
Sub-total	1,542,700	58,000	1,600,700	1,524,300	3,125,000	49.4
Total	1,999,000	58,000	2,057,000	3,667,700	5,724,700	34.9

Table J-A2 -Ownership of commercial forest land, Genesee River Basin, by County and Economic Sub-region, 1964

Sub-region & County	Farm Woodland	Other Private	Total Private	Federal	State	County & Municipal	Total Public	All Owners
	Acres							
Barge Canal								
Monroe	21,600	12,300	33,900	--	--	800	800	34,700
Orleans	16,400	5,100	21,500	--	--	--	--	21,500
Wayne	34,600	79,700	114,300	--	--	--	--	114,300
Sub-total	72,600	97,100	169,700	--	--	800	800	170,500
Central Plains								
Genesee	31,800	23,400	55,200	--	2,300	400	2,700	57,900
Livingston	46,800	5,500	52,300	--	9,700	2,900	12,600	64,900
Ontario	38,500	34,200	72,700	--	1,700	2,900	4,600	77,300
Wyoming	60,900	23,600	84,500	--	--	1,200	1,200	85,700
Sub-total	178,000	86,700	264,700	--	13,700	7,400	21,100	285,800
Allegheny Plateau								
Allegany	108,100	85,300	193,400	--	53,000	1,800	54,800	248,200
Cattaraugus	140,900	197,300	338,200	--	26,900	2,900	29,800	368,000
Steuben	129,300	215,200	344,500	--	21,100	1,300	22,400	366,900
Potter	88,200	194,000	282,200	--	276,600	800	277,400	559,600
Sub-total	466,500	691,800	1,158,300	--	377,600	6,800	384,400	1,542,700
Total	717,100	875,600	1,592,700	--	391,300	15,000	406,300	1,999,000

Table J-A3-Total area of commercial Forest Land by Forest Type in the Genesee River Basin, by County and Economic Sub-region, 1964

Sub-region & county	White pine & hemlock	White pine hard-wood	All other soft-woods	Total soft-woods	Northern hardwoods	Black ash, maple, elm	Oak-hickory	All other hardwoods	Total hardwoods	Total all species
	- - - -	- - - -	- - - -	- - - -	- - - -	Acres	- - - -	- - - -	- - - -	- - - -
Barge Canal										
Monroe	--	--	--	--	--	21,600	--	13,100	34,700	34,700
Orleans	--	--	--	--	--	13,200	--	8,300	21,500	21,500
Wayne	--	--	--	--	20,400	39,800	--	54,100	114,300	114,300
Sub-total	--	--	--	--	20,400	74,600	--	75,500	170,500	170,500
Central Plains										
Genesee	--	--	--	--	15,400	40,300	--	2,200	57,900	57,900
Livingston	2,500	--	--	2,500	5,200	40,100	7,600	9,500	62,400	64,900
Ontario	--	--	--	--	10,300	15,900	51,100	--	77,300	77,300
Wyoming	--	--	--	--	51,900	11,400	7,000	15,400	85,700	85,700
Sub-total	2,500	--	--	2,500	82,800	107,700	65,700	27,100	283,300	285,800
Allegheny Plateau										
Allegany	16,800	--	--	16,800	191,100	--	19,800	20,500	231,400	248,200
Cattaraugus	3,500	--	--	3,500	276,000	3,900	51,900	32,700	364,500	368,000
Steuben	20,000	17,800	--	37,800	127,700	12,600	93,400	95,400	329,100	366,900
Potter (Pa.)	--	9,200	--	9,200	451,600	--	38,900	59,900	550,400	559,600
Sub-total	40,300	27,000	--	67,300	1,046,400	16,500	204,000	208,500	1,475,400	1,542,700
Total	42,800	27,000	--	69,800	1,149,600	198,800	269,700	311,100	1,929,200	1,999,000

Table J-A4—Commercial forest land by stand-size class in the Genesee River Basin, by economic sub-region and county, 1964

County and Sub-region	Saw-timber Stands	Pole-timber Stands	Seedling & Sapling Stands	Other Areas	Total Commercial Forestland
	Acres				
Barge Canal					
Monroe	26,700	--	8,000	--	34,700
Orleans	7,100	--	14,400	--	21,500
Wayne	22,900	50,300	41,100	--	114,300
Sub-total	56,700	50,300	63,500	--	170,500
Central Plains					
Genesee	25,500	8,100	22,000	2,300	57,900
Livingston	26,600	3,300	30,500	4,500	64,900
Ontario	35,600	41,700	--	--	77,300
Wyoming	36,000	12,000	20,600	17,100	85,700
Sub-total	123,700	65,100	73,100	23,900	285,800
Allegheny Plateau					
Allegany	96,800	114,200	37,200	--	248,200
Cattaraugus	147,200	136,200	73,600	11,000	368,000
Steuben	58,700	161,400	113,800	33,000	366,900
Potter (Pa.)	156,700	386,100	16,800	--	559,600
Sub-total	459,400	797,900	241,400	44,000	1,542,700
Total	639,800	913,300	378,000	67,900	1,999,000

Table J-A5–Total volume of live sawtimber and growing stock on commercial forest land by size class of timber and county in the Genesee River Basin, 1964

Sub-region and County	Softwoods		Hardwoods		Total	
	Sawtimber	Growing Stock	Sawtimber	Growing Stock	Sawtimber	Growing Stock
	(Thou. bd.ft.)	(Thou. cu.ft.)	(Thou. bd.ft.)	(Thou. cu.ft.)	(Thou. bd.ft.)	(Thou. cu.ft.)
Barge Canal						
Monroe	--	--	204,000	52,800	204,000	52,800
Orleans	--	--	94,800	27,000	94,800	27,000
Wayne	--	100	226,200	98,400	226,200	98,500
Sub-total	--	100	525,000	178,200	525,000	178,300
Central Plains						
Genesee	--	--	283,500	82,700	283,500	82,700
Livingston	30,300	10,200	364,400	95,500	394,700	105,700
Ontario	4,100	1,500	279,100	97,800	283,200	99,300
Wyoming	27,300	10,000	307,300	99,100	334,600	109,100
Sub-total	61,700	21,700	1,234,300	375,000	1,296,000	396,800
Allegheny Plateau						
Allegany	10,700	16,700	655,500	355,600	666,200	372,300
Cattaraugus	101,900	33,900	991,700	487,000	1,093,600	520,900
Steuben	56,800	27,200	398,900	249,800	455,700	277,000
Potter (Pa.)	20,200	18,800	1,202,100	891,900	1,222,300	910,700
Sub-total	189,600	96,600	3,248,200	1,984,300	3,437,800	2,080,900
Total	251,300	118,400	5,007,500	2,537,600	5,258,800	2,656,000

Table J-A6-Total volume of sawtimber and growing stock on commercial forest land in the Genesee River Basin by ownership class and timber size class, 1964

Sub-region	Softwoods		Hardwoods		Total	
	Sawtimber	Growing Stock	Sawtimber	Growing Stock	Sawtimber	Growing Stock
	(Thou. bd.ft.)	(Thou. cu.ft.)	(Thou. bd.ft.)	(Thou. cu.ft.)	(Thou. bd.ft.)	(Thou. cu.ft.)
Barge Canal						
Farm woodland	--	30	267,800	83,300	267,800	83,330
Other private	--	70	252,500	93,700	252,500	93,770
Total private	--	100	520,300	177,000	520,300	177,100
Federal	--	--	--	--	--	--
State	--	--	--	--	--	--
City & Municipal	--	--	4,700	1,200	4,700	1,200
Total public	--	--	4,700	1,200	4,700	1,200
Total All Ownerships	--	100	525,000	178,200	525,000	178,300
Central Plain						
Farm woodland	43,200	15,200	775,800	233,300	819,000	248,500
Other private	11,900	4,400	353,600	112,100	365,500	116,500
Total private	55,100	19,600	1,129,400	345,400	1,184,500	365,000
Federal	--	--	--	--	--	--
State	4,600	1,500	71,900	19,700	76,500	21,200
City & Municipal	2,000	600	33,000	10,000	35,000	10,600
Total public	6,600	2,100	104,900	29,700	111,500	31,800
Total All Ownerships	61,700	21,700	1,234,300	375,100	1,296,000	396,800
Allegheny Plateau						
Farm woodland	66,900	32,900	995,300	570,000	1,062,200	602,900
Other private	98,600	46,200	1,407,700	839,000	1,506,300	885,200
Total private	165,500	79,100	2,403,000	1,409,000	2,568,500	1,488,100
Federal	--	--	--	--	--	--
State	23,100	17,000	829,600	566,700	852,700	583,700
City & Municipal	1,000	500	15,600	8,600	16,600	9,100
Total public	24,100	17,500	845,200	575,300	869,300	592,800
Total All Ownerships	189,600	96,600	3,248,200	1,984,300	3,437,800	2,080,900
Total All Regions	251,300	118,400	5,007,500	2,537,600	5,258,800	2,656,000

Table J-A6a — Barge Canal Sub-region

County	Softwoods Sawtimber (Thou. bd.ft.)	Softwoods Growing Stock (Thou. cu.ft.)	Hardwoods Sawtimber (Thou. bd.ft.)	Hardwoods Growing Stock (Thou. cu.ft.)	Total Sawtimber (Thou. bd.ft.)	Total Growing Stock (Thou. cu.ft.)
Monroe						
Farm woodland	--	--	127,000	32,900	127,000	32,900
Other private	--	--	72,300	18,700	72,300	18,700
Total private	--	--	199,300	51,600	199,300	51,600
Federal	--	--	--	--	--	--
State	--	--	--	--	--	--
City & Municipal	--	--	4,700	1,200	4,700	1,200
Total public	--	--	4,700	1,200	4,700	1,200
Orleans						
Farm woodland	--	--	72,300	20,600	72,300	20,600
Other private	--	--	22,500	6,400	22,500	6,400
Total private	--	--	94,800	27,000	94,800	27,000
Federal	--	--	--	--	--	--
State	--	--	--	--	--	--
City & Municipal	--	--	--	--	--	--
Total public	--	--	--	--	--	--
Wayne						
Farm woodland	--	30	68,500	29,800	68,500	29,830
Other private	--	70	157,700	68,600	157,700	68,670
Total private	--	100	226,200	98,400	226,200	98,500
Federal	--	--	--	--	--	--
State	--	--	--	--	--	--
City & Municipal	--	--	--	--	--	--
Total public	--	--	--	--	--	--
Total all Ownerships	--	100	525,000	178,200	525,000	178,300

Table J-A6b -- Central Plains Sub-region

County	Softwoods Sawtimber (Thou. bd.ft.)	Softwoods Growing Stock (Thou. cu.ft.)	Hardwoods Sawtimber (Thou. bd.ft.)	Hardwoods Growing Stock (Thou. cu.ft.)	Total Sawtimber (Thou. bd.ft.)	Total Growing Stock (Thou. cu.ft.)
Genesee						
Farm woodland	--	--	155,700	45,400	155,700	45,400
Other private	--	--	114,600	33,400	114,600	33,400
Total private	--	--	270,300	78,800	270,300	78,800
Federal	--	--	--	--	--	--
State	--	--	11,300	3,300	11,300	3,300
City & Municipal	--	--	1,900	600	1,900	600
Total public	--	--	13,200	3,900	13,200	3,900
Livingston						
Farm woodland	21,800	7,400	262,700	68,800	284,500	76,200
Other private	2,600	900	30,900	8,100	33,500	9,000
Total private	24,400	8,300	293,600	76,900	318,000	85,200
Federal	--	--	--	--	--	--
State	4,500	1,500	54,500	14,300	59,000	15,800
City & Municipal	1,400	400	16,300	4,300	17,700	4,700
Total public	5,900	1,900	70,800	18,600	76,700	20,500
Ontario						
Farm woodland	2,000	700	139,000	48,700	141,000	49,400
Other private	1,800	700	123,500	43,300	125,300	44,000
Total private	3,800	1,400	262,500	92,000	266,300	93,400
Federal	--	--	--	--	--	--
State	100	--	6,100	2,100	6,200	2,100
City & Municipal	200	100	10,500	3,700	10,700	3,800
Total public	300	100	16,600	5,800	16,900	5,900
Wyoming						
Farm woodland	19,400	7,100	218,400	70,400	237,800	77,500
Other private	7,500	2,800	84,600	27,300	92,100	30,100
Total private	26,900	9,900	303,000	97,700	329,900	107,600
Federal	--	--	--	--	--	--
State	--	--	--	--	--	--
City & Municipal	400	100	4,300	1,400	4,700	1,500
Total public	400	100	4,300	1,400	4,700	1,500
Total all Ownerships	61,700	21,700	1,234,300	375,100	1,296,000	396,800

Table J-A6c-- Allegheny Plateau Sub-region

County	Softwoods		Hardwoods		Total	
	Sawtimber (Thou. bd.ft.)	Growing Stock (Thou. cu.ft.)	Sawtimber (Thou. bd.ft.)	Growing Stock (Thou. cu.ft.)	Sawtimber (Thou. bd.ft.)	Growing Stock (Thou. cu.ft.)
Allegany						
Farm woodland	4,700	7,300	285,500	154,900	290,200	162,200
Other private	3,700	5,700	225,300	122,200	229,000	127,900
Total private	8,400	13,000	510,800	277,100	519,200	290,100
Federal	--	--	--	--	--	--
State	2,300	3,600	140,000	75,900	142,300	79,500
City & Municipal	--	100	4,700	2,600	4,700	2,700
Total public	2,300	3,700	144,700	78,500	147,000	82,200
Cattaraugus						
Farm woodland	39,000	13,000	379,700	186,500	418,700	199,500
Other private	54,600	18,100	531,700	261,100	586,300	279,200
Total private	93,600	31,100	911,400	447,600	1,005,000	478,700
Federal	--	--	--	--	--	--
State	7,500	2,500	72,500	35,600	80,000	38,100
City & Municipal	800	300	7,800	3,800	8,600	4,100
Total public	8,300	2,800	80,300	39,400	88,600	42,200
Steuben						
Farm woodland	20,000	9,600	140,600	88,000	160,600	97,600
Other private	33,300	15,900	234,000	146,500	267,300	162,400
Total private	53,300	25,500	374,600	234,500	427,900	260,000
Federal	--	--	--	--	--	--
State	3,300	1,600	22,900	14,400	26,200	16,000
City & Municipal	200	100	1,400	900	1,600	1,000
Total public	3,500	1,700	24,300	15,300	27,800	17,000
Potter (Pa.)						
Farm woodland	3,200	3,000	189,500	140,600	192,700	143,600
Other private	7,000	6,500	416,700	309,200	423,700	315,700
Total private	10,200	9,500	606,200	449,800	616,400	459,300
Federal	--	--	--	--	--	--
State	10,000	9,300	594,200	440,800	604,200	450,100
City & Municipal	--	--	1,700	1,300	1,700	1,300
Total public	10,000	9,300	595,900	442,100	605,900	451,400
Total all Ownerships	189,600	96,600	3,248,200	1,984,300	3,437,800	2,080,900

Table J-A7 Total volume of sawtimber on commercial forest land for principal commercial species in the Genesee River Basin by county and economic sub-region, 1964

Species	I	II	III	Total
	------(Thousand board feet)------			
Softwoods:				
White, Red & Jack pine	--	31,700	89,000	120,700
Hemlock	--	30,000	93,900	123,900
Spruce and fir	--	--	1,400	1,400
Other softwoods	--	--	5,300	5,300
Total of all softwoods	--	61,700	189,600	251,300
Hardwoods:				
Hard maple	55,400	182,500	865,400	1,103,300
Soft maple	56,600	226,000	155,200	437,800
Select red oaks	2,500	79,700	415,900	498,100
Select white oaks	4,100	118,900	127,100	250,100
Chestnut oak	--	--	4,700	4,700
Other oaks	--	--	--	--
Hickory	17,800	21,800	23,700	63,300
Yellow birches	1,500	2,900	22,200	26,600
Beech	10,400	109,000	282,200	401,600
Ash, Blk.cherry, Blk.walnut	67,600	53,300	844,000	964,900
Butternut	--	--	--	--
All other hardwoods	309,100	440,200	507,800	1,257,100
Total of all hardwoods	525,000	1,234,300	3,248,200	5,007,500
Total of all species	525,000	1,296,000	3,437,800	5,258,800

Table J-A7a -- Barge Canal Sub-region

Species	Monroe	Orleans	Wayne	Total
	- - - - - -(Thousand board feet) - - - - - - - - -			
Softwoods:				
White, Red & Jack pine	--	--	--	--
Hemlock	--	--	--	--
Spruce and fir	--	--	--	--
Other softwoods	--	--	--	--
Total of all softwoods	--	--	--	--
Hardwoods:				
Hard maple	6,800	1,700	46,900	55,400
Soft maple	11,200	39,700	5,700	56,600
Selected red oaks	2,500	--	--	2,500
Selected white oaks	4,100	--	--	4,100
Chestnut oak	--	--	--	--
Other oaks	--	--	--	--
Hickory	1,600	--	16,200	17,800
Yellow birches	--	--	1,500	1,500
Beech	--	1,800	8,600	10,400
Ash, Blk.cherry, Blk.walnut	18,800	31,200	17,600	67,600
Butternut	--	--	--	--
All other hardwoods	159,000	20,400	129,700	309,100
Total of all hardwoods	204,000	94,800	226,200	525,000
Total of all species	204,000	94,800	226,200	525,000

Table J-A7b -- Central Plains Sub-region

Species	Genesee	Livingston	Ontario	Wyoming	Total
	- - - - - - - -(Thousand board feet)- - - - - - -				
Softwoods:					
White, Red & Jack pine	--	30,100	1,600	--	31,700
Hemlock	--	200	2,500	27,300	30,000
Spruce and fir	--	--	--	--	--
Other softwoods	--	--	--	--	--
Total of all softwoods	--	30,300	4,100	27,300	61,700
Hardwoods:					
Hard maple	72,700	4,400	8,100	97,300	182,500
Soft maple	84,900	75,700	4,600	60,800	226,000
Selected red oaks	--	45,300	34,400	--	79,700
Selected white oaks	--	48,700	70,200	--	118,900
Chestnut oak	--	--	--	--	--
Other oaks	--	--	--	--	--
Hickory	--	--	21,800	--	21,800
Yellow birches	--	--	--	2,900	2,900
Beech	--	9,100	--	99,900	109,000
Ash, Blk.cherry, Blk.walnut	14,600	2,500	12,500	23,700	53,300
Butternut	--	--	--	--	--
All other hardwoods	111,300	178,700	127,500	22,700	440,200
Total of all hardwoods	283,500	364,400	279,100	307,300	1,234,300
Total of all species	283,500	394,700	283,200	334,600	1,296,000

Table J-A7c -- Allegheny Plateau Sub-region

Species	Allegany	Cattaraugus	Steuben	Potter(Pa.)	Total
	(Thousand board feet)				
Softwoods:					
White, Red, & Jack pine	4,300	34,600	35,200	14,900	89,000
Hemlock	6,400	67,300	20,200	—	93,900
Spruce and fir	—	—	1,400	—	1,400
Other softwoods	—	—	—	5,300	5,300
Total of all softwoods	10,700	101,900	56,800	20,200	189,600
Hardwoods:					
Hard maple	191,600	437,100	80,400	156,300	865,400
Soft maple	66,700	39,800	17,500	31,200	155,200
Selected red oaks	74,400	80,100	125,300	136,100	415,900
Selected white oaks	51,500	37,400	38,200	—	127,100
Chestnut oak	700	—	2,500	1,500	4,700
Other oaks	—	—	—	—	—
Hickory	3,300	1,500	18,900	—	23,700
Yellow birches	9,400	12,800	—	—	22,200
Beech	93,300	162,300	26,600	—	282,200
Ash, Blk.cherry, Blk.walnut	43,100	147,200	15,500	638,200	844,000
Butternut	—	—	—	—	—
All other hardwoods	121,500	73,500	74,000	238,800	507,800
Total of all hardwoods	655,500	991,700	398,900	1,202,100	3,248,200
Total of all species	666,200	1,093,600	455,700	1,222,300	3,437,800

Table J-A8--Total volume of growing stock in the Genesee River Basin by species group, county, and economic sub-region, 1964

Species	I	II	III	Total
	- - - - - - - - (Thousand cubic feet) - - -			
Softwoods:				
White, Red & Jack pine	--	10,400	47,400	57,800
Hemlock	100	11,100	44,900	56,100
Spruce and fir	--	--	1,400	1,400
Other softwoods	--	200	2,900	3,100
Total of all softwoods	100	21,700	96,600	118,400
Hardwoods:				
Hard maple	18,400	62,100	465,500	546,000
Soft maple	16,900	55,800	129,200	201,900
Selected red oaks	1,300	22,200	217,300	240,800
Selected white oaks	1,800	30,700	55,400	87,900
Chestnut oak	--	3,500	16,000	19,500
Other oaks	--	--	--	--
Hickory	7,300	9,000	20,900	37,200
Yellow birches	1,500	3,800	42,800	48,100
Beech	3,600	29,700	121,100	154,400
Ash, Blk.cherry, Blk.walnut	19,600	21,400	601,200	642,200
Butternut	--	--	--	--
All other hardwoods	107,800	136,900	314,900	559,600
Total of all hardwoods	178,200	375,100	1,984,300	2,537,600
Total of all species	178,300	396,800	2,080,900	2,656,000

Table J-A8a -- Barge Canal Sub-region

Species	Monroe	Orleans	Wayne	Total
	------ (Thousand cubic feet) ------			
Softwoods:				
White, Red & Jack pine	--	--	--	--
Hemlock	--	--	100	100
Spruce and fir	--	--	--	--
Other softwoods	--	--	--	--
Total of all softwoods	--	--	100	100
Hardwoods:				
Hard maple	2,900	1,500	14,000	18,400
Soft maple	3,700	7,900	5,300	16,900
Select red oaks	500	--	800	1,300
Select white oaks	1,800	--	--	1,800
Chestnut oak	--	--	--	--
Other oaks	--	--	--	--
Hickory	4,000	--	3,300	7,300
Yellow birches	--	--	1,500	1,500
Beech	300	400	2,900	3,600
Ash, Blk.cherry, Blk.walnut	1,000	10,500	8,100	19,600
Butternut	--	--	--	--
All other hardwoods	38,600	6,700	62,500	107,800
Total of all hardwoods	52,800	27,000	98,400	178,200
Total of all species	52,800	27,000	98,500	178,300

Table J-A8b -- Central Plains Sub-region

Species	Genesee	Livingston	Ontario	Wyoming	Total
	- - - - - - - -(Thousand cubic feet)- - - - - - - -				
Softwoods:					
White, Red & Jack pine	--	10,000	400	--	10,400
Hemlock	--	--	1,100	10,000	11,100
Spruce and fir	--	--	--	--	--
Other softwoods	--	200	--	--	200
Total of all softwoods	--	10,200	1,500	10,000	21,700
Hardwoods:					
Hard maple	18,100	5,200	6,400	32,400	62,100
Soft maple	23,900	15,100	2,900	13,900	55,800
Select red oaks	--	11,100	11,100	--	22,200
Select white oaks	--	12,000	18,700	--	30,700
Chestnut oaks	--	3,500	--	--	3,500
Other oaks	--	--	--	--	--
Hickory	--	300	8,500	200	9,000
Yellow birches	--	--	--	3,800	3,800
Beech	700	1,900	1,900	25,200	29,700
Ash, Blk.cherry, Blk.walnut	5,900	700	5,200	9,600	21,400
Butternut	--	--	--	--	--
All other hardwoods	34,100	45,700	43,100	14,000	136,900
Total of all hardwoods	82,700	95,500	97,800	99,100	375,100
Total of all species	82,700	105,700	99,300	109,100	396,800

Table J-A8c -- Allegheny Plateau Sub-region

Species	Allegany	Cattaraugus	Steuben	Potter(Pa.)	Total
	- - - - - - - - (Thousand cubic feet) - - - - - - - - -				
Softwoods:					
White, Red & Jack pine	8,500	12,100	12,900	13,900	47,400
Hemlock	8,200	21,800	12,300	2,600	44,900
Spruce and fir	--	--	1,400	--	1,400
Other softwoods	--	--	600	2,300	2,900
Total of all softwoods	16,700	33,900	27,200	18,800	96,600
Hardwoods:					
Hard maple	101,000	200,700	43,800	120,000	465,500
Soft maple	44,900	32,500	28,100	23,700	129,200
Select red oaks	34,600	42,000	47,600	93,100	217,300
Select white oaks	16,800	14,800	23,800	--	55,400
Chestnut oaks	500	3,200	9,600	2,700	16,000
Other oaks	--	--	--	--	--
Hickory	7,000	4,600	9,300	--	20,900
Yellow birches	21,000	14,400	7,400	--	42,800
Beech	49,000	56,000	16,100	--	121,100
Ash, Blk.cherry, Blk.walnut	27,100	81,300	21,500	471,300	601,200
Butternut	--	--	--	--	--
All other hardwoods	53,700	37,500	42,600	181,100	314,900
Total of all hardwoods	355,600	487,000	249,800	891,900	1,984,300
Total of all species	372,300	520,900	277,000	910,700	2,080,900

Table J-A9-- Estimated amounts of various pesticides used in the Genesee River Basin, determined by applying recommended rates to acreages grown, 1965.

Pesticide	Crops: Vegetables	Dry Beans	Potatoes	Corn & Oats	Total
	Acres				
	20,895	27,395	6,898	134,034	
	Amount of pesticide used				
	Pounds				Pounds
Dinitro	17,180	10,280			27,460
Eptam	70	830			900
Sevin	240	2,050	34,490		36,780
Parathion	560	1,370	27,590		29,520
Karathane	270				270
DDT	44,800				44,800
2,4-T	7,500			32,840	40,340
Solan	980				980
Diphenamid	490				490
Maneb	4,900				4,900
Polyram			62,090		62,090
Nabam			27,590		27,590
Sodium Arsenite			27,590		27,590
Chlordane	1,100				1,100
M.C.P.				2,350	2,350
Atrazine				88,460	88,460
Total	78,090	14,530	179,350	123,650	395,620

Source: Interviews with extension personnel of the College of Agriculture at Cornell University, Ithaca, New York

Table J-A10- Estimated amount of pesticides used in the Genesee River Basin based on average of farm expenditures for pesticides, 1965. 1/

Crop	Acreage of Crops Using Pesticides 2/		Pesticide Used	Price 4/ per Pound	Per Acre Expenditure for Pesticide	Pounds of Pesticide per Crop Acre
	Acres	Percent		Dollars	Dollars	Pounds
Corn grain	32,000	16	Atrazine	2.30		0.02
Corn silage	30,000	15	2,4-D	0.70	0.07	0.10
Oats						
Not seeded	36,000	19	Dinitro	0.23	0.10	0.43
Seeded	36,000	19	Premerge	0.50	0.10	0.20
Vegetables, Potatoes, dry beans, etc.	60,000	31	Mixture of herbicides, insecticides, fungicides 3/	0.68	0.15	0.22
Total	194,000	100	-	-	0.10 5/	0.21

1/ L. C. Cunningham, "An Economic Study of Commercial Dairy Farms, Central Plain Region, New York, 1963-64." A. E. Res. 192, Department of Agricultural Economics, Cornell University, Ithaca, New York. February 1966, p. 20.

2/ From Economic Base Study of the Genesee River Basin.

3/ Mixture was determined from Table A-9 and includes insecticides as well as herbicides.

4/ Prices are 1966 prices.

5/ The 404 farms in the survey spent $0.10 on spray material for each acre of crops harvested.

Table J-411-- Estimated number of fish killed in New York and the estimated number killed by agricultural poisons. 1/

	1960	1961	1962	1963	1964
	- - - - - - - -	- - - - - - - -	Number	- - - - - - - -	- - - - - - - -
Number killed in New York	10,336	33,000	230,260	383,225	149,400
Number killed by agricultural poisons	N.R.	2,800	0	3,250	11,350
Percent	N.R.	8.5	0	0.8	7.6

1/ N.R. = Not reported.

Source: "Pollution Caused Fish Kills", U. S. Department of Health, Education and Welfare, Public Health Service, Division of Water Supply and Pollution Control, Basic Data Branch.

Table J-A12-- Trends in fertilizer use in New York State, 1940 to 1959.

	1940-1944		1950-1954		1959	
	Tons	Percent	Tons	Percent	Tons	Percent
Fertilizer	472,791		628,843		592,295	
Nitrogen	14,531	3.0	31,275	5.0	45,522	8.0
Phosphorus	69,056	15.0	78,243	12.0	69,997	12.0
Potash	21,052	4.0	42,251	7.0	57,382	10.0

Table J-A13-- Estimated use of fertilizer in the Genesee River Basin. by county, 1959

County	Tons
NEW YORK	
Allegany	5,870
Cattaraugus	70
Genesee	9,280
Livingston	15,100
Monroe	6,000
Ontario	3,000
Orleans	140
Steuben	2,200
Wyoming	8,160
PENNSYLVANIA	
Potter	400
Total	50,220

Table J-A14-- Estimated number of pounds of Nitrogen, Phosphate, and Potash in the manure produced by the livestock found in the Genesee River Basin, 1959. 1/

Type	Number of Livestock	Nitrogen	Phosphate	Potash	Manure per Year	N	P	K	N	P	K
	Number	Thousand pounds	Thousand pounds	Thousand pounds	Pounds per animal	Percent			Pounds		
Cattle and calves	146,500	16,555	4,102	12,453	18,900	0.60	0.15	0.45	113	28	85
Sheep and lambs	44,000	484	176	528	1,200	0.95	0.35	1.00	11	4	12
Horses	3,000	378	135	297	18,000	0.70	0.25	0.55	126	45	99
Hogs and pigs	17,000	510	357	408	6,000	0.50	0.35	0.40	30	21	24
Chickens	393,000	157	118	79							
Hens					40	1.00	0.80	0.40	.4	.3	.2

1/ Lyon, T. L. and Buckman, H. O. "The Nature and Properties of Soils", The MacMillan Company, New York, 1950.

Table J-A15 - Average annual loss of nutrients by percolation through bare and cropped soils, Cornell Lysimeters 1/, average of ten and fifteen years, respectively.

Soil Condition	Pounds to the Acre a Year					
	N	P_2O_5	K_2O	CaO	MgO	SO_3
Dunkirk silty clay loam						
Bare	69.0	Trace	86.8	557.2	104.4	132.5
Rotation	7.8	Trace	69.1	322.0	73.2	108.5
Grass	2.5	Trace	74.5	364.0	83.1	111.1
Volusia silt loam						
Bare	43.0	Trace	77.3	452.6	68.3	88.5
Rotation	6.6	Trace	68.9	350.5	45.7	82.0

1/ Lyon, T. L. and Bizzell, J. A., "Lysimeter Experiments IV", Memoir 194, Cornell University Agricultural Experiment Station, 1936.

Table J-A16-Average annual loss of nutrients by percolation through soils cropped to a rotation, Craibstone Lysimeters 1/, Average for six years.

Soil Treatment	Pounds to the acre a year				
	N	P_2O_5	K_2O	CaO	MgO
Untreated	6.7	Trace	10.6	69.6	25.5
Manures and fertilizer	6.3	Trace	9.9	78.5	26.5
Manure, fertilizer, and lime	7.9	Trace	9.2	111.4	31.2

1/ Hendrick, J. and Welch, H. D. "The Substance Removed by the Drainage from a Scottish Soil." Proc. and Papers, First International Congress of Soil Scientists, II; 358-366, 1927.

Table J-A17-Nutrient content of drainage water from forested, urban, and agricultural areas.

	Mean nutrient concentrations (ppb)			
	Total Phosphorus	Soluble Phosphorus	Nitrates	Total Kjeldahl Nitrogen
Urban street drainage 1/	208	76	527	2,010
Streams from forested areas 2/	69	7	130	74
Subsurface irrigation drains 3/	216	184	2,690	172
Surface irrigation drains 3/	216	162	1,250	205

1/ From major highways, arterial and residential streets from thirty minutes to several hours after a rainstorm had commenced.

2/ From three streams containing large reservoirs, roads, and some logging, but no human habitation.

3/ From the Yakima River Basin irrigation return flow drains.

Source: Sylvester, R. O. "Nutrient Content of Drainage Water from Forested, Urban, and Agricultural Areas. Algae and Metropolitan Wastes," U. S. Public Health Service, Sec. TR W61-3, pp. 80-87, 1961.

Table J-A18- Nutrients removed annually [1] in pounds to the acre in the Missouri Erosion Experiment. [2]

Conditions	Pounds to the acre annually					
	N	P_2O_5	K_2O	CaO	MgO	SO_3
Corn grown continously	66	41	729	309	145	42
Rotation: Corn, wheat and clover	26	18	258	120	48	15

1/ These data are from records for two years only.

2/ Miller, M. F. and Krusekopf, H. H., "The Influence of Systems of Cropping and Methods of Culture on Surface Run-Off and Soil Erosion", Research Bulletin 177, Missouri Agricultural Experiment Station, 1932.

Table J-A19- Projected Production of Lumber, Woodpulp, and Paper and Paperboard in the Economic Area of the Genesee River Basin for Selected Years.

	Year					
	1960	1970	1980	1990	2000	2020
LUMBER PRODUCTION				MILLION BOARD FEET		
Economic sub-area:						
Barge Canal	2.9	2.9	3.3	3.9	4.3	5.3
Central Plain	7.9	7.9	9.1	10.8	12.1	14.5
Allegheny Plateau	61.0	61.4	70.6	83.2	93.2	112.2
TOTAL	71.8	72.2	83.0	97.9	109.6	132.0
WOODPULP PRODUCTION				THOUSAND TONS		
Economic sub-area:						
Barge Canal	--	--	20	25	25	30
Central Plain	--	--	--	--	20	25
Allegheny Plateau	--	--	20	25	30	35
TOTAL	--	--	40	50	75	90
PAPER AND BOARD PRODUCTION				THOUSAND TONS		
Economic sub-area:						
Barge Canal	20	25	30	30	40	40
Central Plain	20	25	30	30	40	40
Allegheny Plateau	--	--	20	25	30	35
TOTAL	40	50	80	85	110	115

Table J-A20- Projected Employment in the Lumber and Wood Products Industry in the Economic Area of the Genesee River Basin for Selected Years.

	Year 1960	1970	1980	1990	2000	2020
	THOUSANDS OF EMPLOYEES					
PRIMARY EMPLOYMENT (SIC-241 & 242)**						
Sub-area:						
Barge Canal	1/	1/	1/	1/	1/	1/
Central Plain	0.1	0.1	0.1	0.1	0.1	0.1
Allegheny Plateau	0.8	0.7	0.7	0.7	0.6	0.5
TOTAL	0.9	0.8	0.8	0.8	0.7	0.6
SECONDARY EMPLOYMENT (SIC-243,244,249)**						
Sub-area:						
Barge Canal	0.4	0.3	0.3	0.3	0.3	0.2
Central Plain	0.3	0.3	0.3	0.3	0.2	0.2
Allegheny Plateau	0.5	0.5	0.4	0.4	0.4	0.3
TOTAL	1.2	1.1	1.0	1.0	0.9	0.7
TOTAL: ALL EMPLOYMENT	2.1	1.9	1.8	1.8	1.6	1.3

** Standard Industrial Classification

1/ Less than 50 persons.

Table J-A21-Projected Employment in the Pulp and Paper Manufacturing Industry in the Economic Area of the Genesee River Basin for Selected Years.

	Year					
	1960	1970	1980	1990	2000	2020
	THOUSANDS OF EMPLOYEES					
PRIMARY EMPLOYMENT (SIC-261,262,263 & 266)*						
Sub-area:						
Barge Canal	0.2	0.2	0.2	0.1	0.2	0.1
Central Plain	0.2	0.2	0.2	0.1	0.2	0.1
Allegheny Plateau	--	--	0.1	0.1	0.1	0.1
TOTAL	0.4	0.4	0.5	0.3	0.5	0.3
SECONDARY EMPLOYMENT (SIC-264 & 265)*						
Sub-area:						
Barge Canal	2.3	2.4	2.6	2.7	2.9	3.2
Central Plains	0.8	0.8	0.8	0.9	0.9	1.0
Allegheny Plateau	0.4	0.4	0.4	0.4	0.5	0.5
TOTAL	3.5	3.6	3.8	4.0	4.2	4.7
TOTAL: ALL EMPLOYMENT	3.9	4.0	4.3	4.3	4.7	5.0

* Standard Industrial Classification

Table J-A22-Projections of production in Ontario Plain, Genesee River Basin, as a percentage of projected Middle Atlantic Region's production, 1960, and by decades to 2020

Commodity	1960	Projections 1970	1980	1990	2000	2010	2020
				Percent			
Beef and veal	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lamb and mutton	2.0	1.8	1.6	1.4	1.3	1.2	1.0
Hogs and pigs	0.4	0.4	0.4	0.4	0.3	0.3	0.3
Milk sold	1.5	1.6	1.8	1.9	2.1	2.2	2.4
Broilers	0	0	0	0	0	0	0
Chickens	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Eggs sold	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Wheat	3.6	3.8	4.0	4.1	4.2	4.2	4.2
Dry beans	15.0	15.5	16.0	16.5	17.0	17.5	18.0
Potatoes	1.3	1.0	0.8	0.7	0.6	0.6	0.5
Vegetables	3.5	3.7	3.8	3.9	4.1	4.2	4.4
Fruit	0.8	0.8	0.7	0.7	0.6	0.6	0.5

Table J-A23- Projections of Production in Allegheny Plateau, Genesee River Basin, as a percentage of projected Middle Atlantic Region's production, 1960, and by decades to 2020.

Product	1960	Projections 1970	1980	1990	2000	2010	2020
	Percent						
Beef and Veal	1.2	1.2	1.1	1.0	1.0	1.0	0.9
Lamb and Mutton	1.9	1.9	1.8	1.7	1.6	1.5	1.4
Hogs and Pigs	0.2	0.2	0.1	0.1	0.1	0.0	0.0
Milk sold	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Broilers	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Chickens	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Eggs sold	0.3	0.2	0.2	0.1	0.1	0.0	0.0
Wheat	1.5	1.6	1.7	1.7	1.7	1.8	1.8
Dry beans	4.0	3.5	3.0	2.5	2.0	1.5	1.0
Potatoes	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Vegetables	1.5	1.5	1.6	1.7	1.7	1.8	1.8
Fruit	0.3	0.2	0.2	0.1	0.1	0.0	0.0

Table J-A24- Current and projected requirements for major farm products, Ontario Plain, Genesee River Basin, 1960, and by decades from 1970 to 2020.

Commodity	Unit	1960	Projections 1970	1980	1990	2000	2010	2020
		- - - - - -	- - - - - -	- - - -	M i l l i o n s	- - - -	- - - - - -	- - - - - -
Beef and veal	pound 1/	14.6	16.8	19.0	22.5	26.5	31.5	37.4
Lamb and mutton	pound 1/	1.0	1.0	1.0	1.0	1.2	1.3	1.3
Pork	pound 1/	2.0	2.0	2.0	2.0	2.0	2.0	3.0
Milk	pound	331.0	404.7	519.5	640.5	828.0	1,017.5	1,304.5
Broilers	pound 1/	0	0	0	0	0	0	0
Chickens	pound 1/	.5	.5	.5	1.0	1.0	1.0	1.5
Eggs	number	39.5	38.0	36.0	42.5	50.5	59.0	69.0
		- - - - - -	- - - - - -	- - - -	T h o u s a n d s	- - - -	- - - - - -	- - - - - -
Wheat	Bushel	1,237.5	1,336.5	1,269.0	1,403.6	1,561.0	1,704.5	1,870.0
Dry beans	Cwt.	160.4	193.8	229.0	273.5	329.3	396.0	477.5
Potatoes	Cwt.	503.5	430.0	395.0	404.4	407.5	479.6	470.6
Vegetables	Cwt.	2,114.5	2,566.5	3,068.7	3,692.5	4,553.5	5,483.8	6,765.5
Fruit	Ton	11.6	13.6	15.5	19.3	19.8	24.0	24.0

1/ Live weight.

Table J-A25- Current and projected requirements for major farm products, Allegheny Plateau, Genesee River Basin, 1960, and by decades from 1970 to 2020.

Commodity	Unit	1960	Projections					
			1970	1980	1990	2000	2010	2020
		Millions						
Beef and veal	pound1/	17.4	20.2	21.0	22.5	26.5	31.5	33.6
Lamb and mutton	pound1/	1.0	1.0	1.0	1.0	1.8	1.7	1.7
Pork	pound1/	1.0	1.0	0	1.0	1.0	0	0
Milk	pound	375.0	430.3	490.5	573.5	670.0	786.5	924.5
Broilers	pound1/	5.0	5.0	6.0	7.0	8.0	10.0	11.0
Chickens	pound1/	0.5	0.5	0.5	1.0	1.0	1.0	1.5
Eggs	number	29.5	19.0	18.0	10.5	12.5	0	0
		Thousands						
Wheat	Bushel	515.5	562.5	539.0	582.4	632.0	730.5	803.0
Dry beans	Cwt.	47.6	34.2	43.0	41.5	38.7	34.0	26.5
Potatoes	Cwt.	1,045.5	1,163.0	1,333.0	1,559.6	1,834.5	2,158.4	2,541.4
Vegetables	Cwt.	906.5	1,040.5	1,292.3	1,609.5	1,888.5	2,350.2	2,767.5
Fruit	Ton	4.4	3.4	4.5	2.7	3.2	0	0

1/ Live weight.

Table J-A26. Feed unit requirements by livestock products, Ontario Plain, Genesee River Basin, 1960, and projected by decades from 1970 to 2020.

Commodity	1960	Projections					
		1970	1980	1990	2000	2010	2020
	- - - - -	- - - - -	M i l l i o n s	o f	f e e d	u n i t s - - -	- - - - -
Beef and veal	170.8	186.5	199.5	218.3	235.9	252.0	265.5
Lamb and mutton	13.1	12.7	12.0	11.1	12.1	11.7	10.5
Pork	9.6	8.8	8.0	7.6	7.2	7.0	6.8
Milk	343.2	380.4	441.6	499.6	604.4	712.3	900.1
Broilers	0	0	0	0	0	0	0
Chickens	1.6	1.4	1.3	2.3	2.2	2.2	3.3
Eggs	18.9	17.3	14.7	16.0	17.6	19.0	21.0
Total	557.2	607.1	677.1	754.9	879.4	1,004.2	1,207.2

Table J-A27- Feed unit requirements by livestock product, Allegheny Plateau, Genesee River Basin, 1960, and projected by decades from 1970 to 2020.

Commodity	1960	Projections					
		1970	1980	1990	2000	2010	2020
	- - - -	- - - - M i l l i o n s	o f	f e e d	u n i t s	- - - -	- - - -
Beef and veal	203.6	224.2	220.5	229.3	235.9	252.0	239.6
Lamb and mutton	13.1	12.7	12.0	11.1	18.2	15.3	13.8
Pork	4.8	4.4	0	3.8	3.6	0	0
Milk	390.0	404.5	416.9	447.3	489.1	550.6	639.9
Broilers	16.0	14.0	15.0	16.1	17.6	22.0	24.2
Chickens	1.6	1.4	1.3	2.3	2.2	2.2	3.3
Eggs	14.1	8.7	7.3	4.0	4.4	0	0
Total	643.2	669.9	673.0	713.9	771.0	842.1	920.8

Table J-A28- Feed unit requirements by feed crop, Ontario Plain, Genesee River Basin, 1960, and projected by decades from 1970 to 2020.

	1960	Projections 1970	1980	1990	2000	2010	2020
	- - - - - - - - -	- - - - Millions	of feed	units - - -			- - - - - -
Concentrate feeds	272	298	332	370	430	492	592
Corn grain	52	53	60	69	81	94	109
Oats	55	62	69	81	90	105	121
Miscellaneous	5	6	6	7	8	9	10
Deficit	160	177	197	213	251	284	352
Roughage feeds	285	309	345	385	449	512	615
Hay	152	164	183	204	238	271	326
Corn silage	77	84	93	104	121	138	166
Pasture	56	61	69	77	90	103	123
Total	557	607	677	755	879	1,004	1,207

Table J-A29--Feed unit requirements by feed crop, Allegheny Plateau, Genesee River Basin, 1960, and projected by decades from 1970 to 2020.

	1960	Projection 1970	1980	1990	2000	2010	2020
	- - - - -	- - - - -	- - M i l l i o n s	o f	f e e d	u n i t s	- - - - -
<u>Concentrate feeds</u>	280	289	289	306	329	357	387
Corn grain	28	28	27	26	25	26	26
Oats	65	67	68	72	77	84	92
Miscellaneous	6	6	6	6	7	8	8
Deficit	181	188	188	202	220	239	261
<u>Roughage feeds</u>	363	381	385	408	443	485	534
Hay	227	234	242	258	280	306	340
Corn silage	64	67	68	71	75	80	87
Pasture	72	80	75	79	88	99	107
Total	643	670	674	714	772	842	921

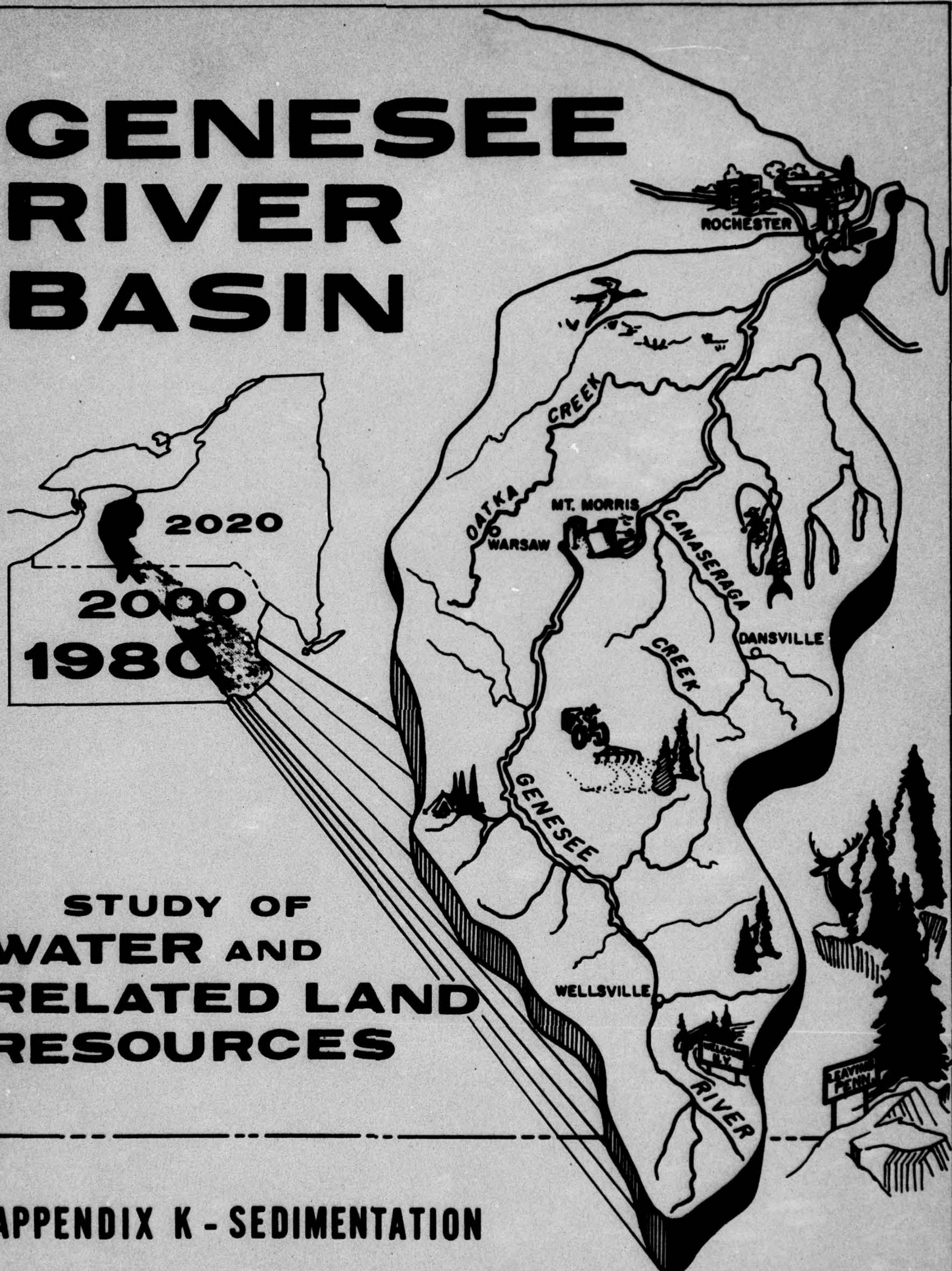
Table J-A30--Water requirements per unit for various consumptive users, 1960, and projected by decades from 1970 to 2020.

Type of User or Product	Unit	1960	Projections 1970	1980	1990	2000	2010	2020
		Gallons of water per unit						
Milk	pound	1.3	1.1	1.0	0.95	0.91	0.88	0.86
Dairy cows	per cow/day	30.0	31.0	34.0	37.0	40.0	44.0	47.0
Beef and veal	pound	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Lamb and mutton	pound	9.6	9.6	9.6	9.6	9.6	9.6	9.6
Eggs	per egg	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Horses	per horse/ day	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Hogs and pigs	pound	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Broiler and farm chickens	pound	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Orchard 1/	acre	4,100.0	4,100.0	4,100.0	4,100.0	4,100.0	4,100.0	4,100.0
Irrigation 2/	acre	326,000.0	326,000.0	326,000.0	326,000.0	326,000.0	326,000.0	326,000.0
Domestic								
Urban	per capita/day	80.0	116.0	152.0	174.0	188.0	200.0	210.0
Small town	do	60.0	76.0	92.0	108.0	124.0	140.0	156.0
Rural, non-farm	do	46.0	46.0	68.0	88.0	104.0	120.0	136.0
Rural, farm	do	46.0	46.0	68.0	88.0	104.0	120.0	136.0

1/ While more trees are planted, sprays will be more concentrated. Anticipate about the same quantity.

2/ Assume about one-half of the water stored is actually applied to the field. Under conditions where water is not stored, 163,000 gallons per acre can be used.

GENESEE RIVER BASIN



STUDY OF WATER AND RELATED LAND RESOURCES

APPENDIX K - SEDIMENTATION

GENESEE RIVER BASIN

COMPREHENSIVE

STUDY OF

WATER AND RELATED LAND RESOURCES

APPENDIX K

SEDIMENTATION

Prepared

By

Bruce K. Gilbert

U.S. Geological Survey

1967

For

U.S. Army Engineer District

Buffalo Corps of Engineers

Buffalo, New York 14207

CONTENTS

ILLUSTRATIONS

INTRODUCTION

Authorization

The United States Senate Committee on Public Works in 1962 directed the U.S. Corps of Engineers to prepare a comprehensive plan for the development of water and related land resources of the Genesee River basin in coordination with the State of New York, the Commonwealth of Pennsylvania, and other Federal agencies. Consequently, the Genesee River Basin Coordinating Committee was formed and a plan was developed to insure that all the necessary studies would be made to efficiently achieve this goal. Major tasks were defined and assigned to participating agencies in accordance with their capabilities.

The study of sedimentation in the basin was assigned to the U.S. Corps of Engineers, U.S. Soil Conservation Service, U.S. Forest Service, U.S. Public Health Service, New York State Conservation Department's Division of Water Resources, and the U.S. Geological Survey. The U.S. Geological Survey was designated as the agency responsible for the formulation of an overall report of this work.

The U.S. Public Health Service was interested in sedimentation in the basin to the extent that it might affect the quality of water available for use. The New York State Conservation Department coordinated the study with State agencies that might have need for information related to sedimentation. The responsibilities of the other agencies actively participating in this phase of the study will be discussed subsequently.

Format of this Report

This report has been assembled to provide the reader with a concise picture of the investigations of sedimentation in the Genesee River basin in the section entitled "Summary." It also provides the more detailed technical reports of the individual agencies in the section entitled "Attachments." For other information related to sedimentation in the basin, reference should be made to Appendix H -- Water Supply and Water-Quality Management and Appendix J -- Agricultural Studies.

Purpose and Scope

The purposes of the investigations of sedimentation in the Genesee River basin were: to provide data needed in the planning for adequate storage of sediment in proposed reservoirs; to identify the location of critical areas of erosion for purposes of evaluating the feasibility of remedial treatment; and to establish the magnitude of the sediment problem at this period in time as a basis for comparison in the future.

The U.S. Geological Survey determined quantities of sediment being transported at key locations in the basin by its standard methods of measuring sediment concentration in streams and relating these measurements to concurrent quantities of streamflow. These data were supplied to the other agencies for use in planning storage requirements for sediment at proposed damsites. However, the method used requires stream-gaging stations (particular sites on streams where systematic observations of flow are obtained, usually on a continuous basis) to provide flow data. Therefore, locations where sediment measurements were made did not necessarily correspond exactly to proposed damsites. The U.S. Corps of Engineers used these data and extrapolated from them to evaluate conditions of expected sediment deposition at sites with which they were concerned.

The U.S. Soil Conservation Service used detailed surveys of geology and land use to estimate amounts of storage required for sediment at proposed damsites in upland areas. For this investigation, the term "upland areas" is defined as all portions of the basin exclusive of the main valley and flood plain of the Genesee River and Canaseraga, Honeoye, Oatka, and Black Creeks. The Soil Conservation Service also carried out a program to identify locations where erosion is taking place and to recommend watershed protection measures where feasible.

The Corps of Engineers and the Geological Survey coordinated investigations of streambank erosion along the Genesee River. The Corps of Engineers also evaluated the economic benefits of providing remedial treatment to such areas to prevent further damages.

The U.S. Forest Service attempted to determine the extent of areas of critical erosion on forested lands by surveying forest hydrologic conditions. It was found that such an analysis could not be made in a meaningful manner within the confines of this study. However, the Forest Service has contributed a general discussion of the condition of forest land in the basin and has made suggestions to decrease the erosion of these lands.

Acknowledgments

Valuable assistance was received at many times throughout the study from the U.S. Weather Bureau and the U.S. Agricultural Stabilization and Conservation Service.

The U.S. Geological Survey was able to assume its duties as the agency responsible for the sedimentation work in the Genesee River basin through an interagency support agreement with the U.S. Corps of Engineers.

SUMMARY

The Occurrence of Fluvial Sediment

Fluvial sediment is material that has been transported or deposited by streams and is often thought of as mud or silt. However, it also includes organic debris and material both coarser and finer than silt. The sediment is either suspended in the water or moved along the bottom of streams until finally deposited.

Sheet erosion and channel erosion are the major sources of this fluvial sediment. Sheet erosion is the primary source of sediments in the uplands areas. It is the detachment of soil particles by raindrop impact and removal by overland flow. Channel erosion occurs as a result of the concentrated flow of water and includes gully erosion, streambed and streambank erosion, and flood-plain scour.

The methods used by the U.S. Geological Survey to evaluate quantities of sediment transported by streams is fully explained in the report entitled, "The Occurrence and Characteristics of Fluvial Sediment in the Genesee River Basin -- a Reconnaissance" by F. J. Keller and B. K. Gilbert, which is included as Attachment A to this report. Briefly, the method entails the collection of samples representative of the water and suspended-sediment mixture in a stream, correlation with concurrent streamflows, and sufficient streamflow record on which to develop a long term flow-duration curve. These data permit calculation of average annual suspended-sediment discharge. A 10 percent allowance for bedload sediment is added to this figure to produce an overall estimate of average annual sediment discharge.

Sediment doesn't necessarily remain in constant motion from the time it is first eroded until finally deposited. Fine particles as well as coarse may be eroded and deposited many times before reaching a stream. This process also persists in streams and rivers but usually to some lesser degree. Thus, the sediment measured in a stream at any specific site is an indication only of the net loss from the drainage area upstream at the time the measurement is made.

Samples were collected and average annual sediment discharge estimated at 14 sites as shown in figure 1. It can be noted that average annual sediment discharges range from 75 to 1,100 tons per square mile of contributing area. The data collected at Avon, the furthest downstream site measured on the Genesee River, indicate that an average of 1.2 million tons of sediment are transported each year from the 1,666 square miles of the drainage basin. Figure 1 shows that the average annual sediment discharge increased in progression downstream from site to site along the Genesee River. The sediment discharges for stations on Canaseraga Creek remained relatively constant, while those for Oatka Creek decreased in a downstream direction. The basinwide variations in the quantities of sediment

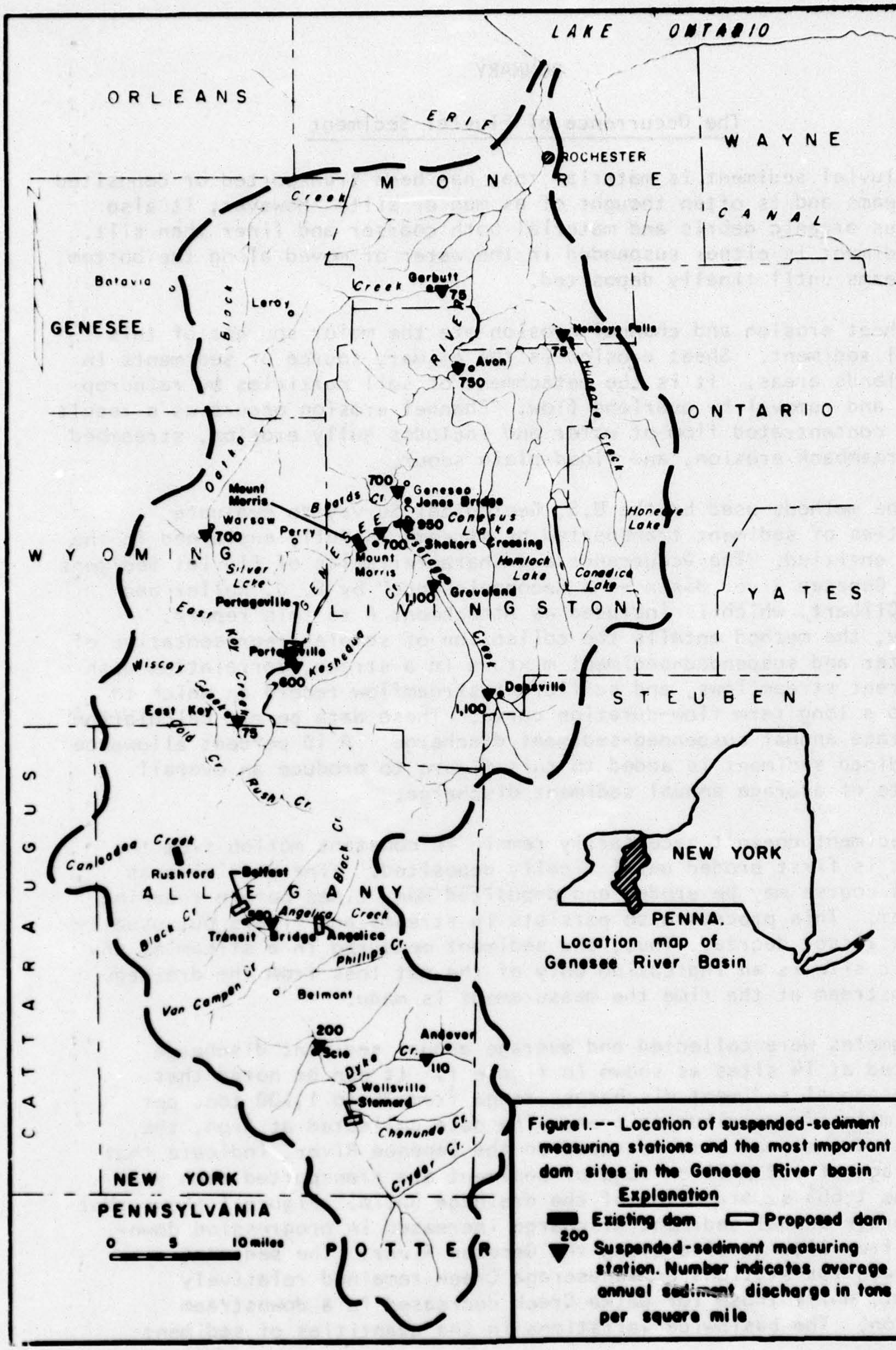


Figure 1.-- Location of suspended-sediment measuring stations and the most important dam sites in the Genesee River basin

transported are caused by numerous interrelated factors. These include stream-channel hydraulics, quantity of runoff from the land surface, antecedent climatic conditions, season, type and size gradation of material available to erosive forces, land use, and topography.

All findings indicate that the Genesee River and many of its tributaries may carry enough sediment to warrant consideration of sediment in the evaluation of a proposed reservoir site or water-treatment facility. However, no critical areas of sheet erosion were found and the most obvious sources of sediment are the streambanks. The streambank erosion has caused localized losses of farmland, and buildings occasionally have been placed in peril. At the present stage of basin development, the most troublesome aspect of sedimentation is deposition rather than erosion. Such problems exist to varying degrees in all reservoirs behind dams on streams in the basin. The most costly deposition problem occurs in Rochester Harbor where annual dredging by the U.S. Corps of Engineers is required to maintain navigation. About 50 acre-feet of sediment are removed yearly and, although the density of the material is not known, this volume may represent a weight of sediment on the order of from 60,000 to 80,000 tons. Figure 2 is an aerial view of Rochester Harbor showing the Genesee River discharging into Lake Ontario.

Sheet and Channel Erosion in the Uplands

The Soil Conservation Service was given the responsibility of studying sheet and channel erosion in the upland areas. These activities are described in Attachment C, which was prepared by the Soil Conservation Service. The summary from Attachment C follows.

Soil losses in the uplands of the Genesee River Basin were computed on a composite acre basis by soil associations. These losses were less than 3.0 tons per acre which is considered allowable by the U.S. Soil Conservation Service. Channel erosion, including streambank and streambed, do occur in the uplands but mainly to low value land making protection unjustifiable on a watershed basis.

Required sediment storage for reservoirs is 0.27 acre feet per square mile per year. This figure was derived by estimating the soil losses in the basin and considering a limited number of reservoir sediment surveys. It is not considered to be a critical loss of storage.

Erosion and Hydrologic Conditions of Forest Land

The U.S. Forest Service found that the portion of the Genesee River basin contributing the smallest relative amount of sediment is the 27 percent that has a forest cover, and has supplied the following discussion of the effect of forest conditions on sedimentation.

Figure 2.--Aerial view of Rochester Harbor, Rochester, N. Y. (from U.S. Corps of Engineers, Buffalo District). The Genesee River empties into Lake Ontario carrying a distinctive burden of sediment. The U.S. Corps of Engineers dredges about 50 acre-feet of deposited material each year to maintain navigation in the harbor.

"Under good forest cover is normally found a protective covering of leaves and debris over the soil surface and a loose, friable soil through which water passes rapidly and which is capable of temporarily storing sizable quantities of water. With little or no exposed mineral soil and with the precipitation entering the soil rather than flowing over the surface, there is a minimum of soil erosion and sediment production. If some erosion does occur, much of the eroded material is trapped by the litter and debris on the forest floor and in the depressions characteristic of the microrelief of forest land.

However, forested areas in the basin are not all in good condition. In some areas fire has destroyed or damaged the protective ground cover; in others, grazing has compacted the soil; in still others, poor logging practice and poorly located, constructed, and maintained logging roads have resulted in accelerated erosion and sediment production.

Most of the forested areas are found on the steeper slopes and shallower soils of the basin. These sites, without an adequate forest cover, are the most subject to erosion and are the most critical from the standpoint of sediment production.

The areas acquired by the State of New York as Reforestation Areas provide demonstration of desirable management for adjacent lands in private ownership.

The Forest Service suggests that technical assistance programs to improve hydrologic conditions and reduce the sediment contribution of forest land should be intensified. They should include cultural operations to maintain or improve the hydrologic condition and protection of forest lands from destructive cutting, logging, and grazing. Present fire protection is adequate."

Evaluation of Erosion Along the Main Stem of the Genesee River

Examination of aerial photographs indicates that numerous sections of the banks of the Genesee River have been subjected to an indeterminate amount of erosion and that localized losses of farmland have taken place. These observations plus the results of field reconnaissance of such areas by personnel of the U.S. Corps of Engineers and the U.S. Geological Survey were combined to produce figure 2 in Attachment A. This figure shows locations of eroding banks from the New York-Pennsylvania State line to Avon, N. Y. but does not attempt to quantify this erosion. Areas of deposition could not be defined in a like manner and, therefore, it should not be inferred that all material eroded from the streambanks was immediately carried downstream and out of the basin. Without doubt, many of the scour areas are representative of the natural meander processes of the Genesee River whereby material eroded from the outside of one curve is deposited on the inside of the next. Plates K1B, K2B, and K3B in Attachment B by the U.S. Corps of Engineers illustrate such

changes in the alignment of the Genesee River's channel in the vicinity of Jones Bridge and Belfast. Also included in Attachment B are photographs of eroded streambanks along the Genesee River. See, for example, figures 3 to 6.

Studies of streambank erosion and the economics of possible remedial measures have led the U.S. Corps of Engineers to conclude that a major bank stabilization project for the entire main stem of the Genesee River is not justified at this time. However, it is recommended that further studies be made of problem areas in the vicinity of the villages of Belfast, Houghton, and Fillmore and in the town of Scio. Problems on tributaries are more localized in nature and it is felt that remedial measures for them will have to be taken by local authorities.

Reservoir Sedimentation Studies

Water Impoundment Sites in Upland Areas

The U.S. Soil Conservation Service used the average net erosion factor they developed to estimate quantities of sediment that can be expected to be delivered to proposed reservoir sites in upland areas. The proposed reservoirs were assumed to have a trap efficiency of 90 percent (that is, 90 percent of the sediment carried by a stream would be deposited in the pool behind the dam). Experience indicates this estimate to be reasonable for the type of dam proposed.

Sediment *accumulation in* selected reservoirs through 1960, in New York and Pennsylvania, is shown in figure 6 in Attachment A to indicate current conditions in the Genesee River basin and other nearby areas. The data show that the average annual accumulation of sediment in those reservoirs listed ranges from 0.036 to 0.41 acre feet per square mile. The annual accumulation in Mount Morris Reservoir was about 0.23 acre feet (383 tons) per square mile and in Rushford Lake about 0.37 acre feet (484 tons) per square mile.

Water Impoundment Sites on Large Tributaries and on the Genesee River

The U.S. Corps of Engineers estimated the trap efficiency of each proposed reservoir from data on method of operation and physical properties of the dam and conditions in the area upstream. Then, using information on the expected quantity and characteristics of the sediment carried by the stream, the Corps evaluated the effect of deposition of sediment on reservoir storage capacity. The methodology is briefly discussed in Attachment B on pages 13 and 14, and the results are summarized in plate K4B.

Studies were made of proposed reservoirs on Angelica Creek and on the Genesee River at Stannard, Belfast, and Portageville. The existing reservoir on the Genesee River at Mount Morris was also studied, and, under the present method of operations, the trap efficiency was considered to be that of a "semi-dry" reservoir. Locations of these sites are shown in figure 1. Each reservoir was evaluated individually, and various combinations of reservoirs were investigated as integrated systems. Detailed planning and final design of dams will require more extensive studies of the problem of sediment deposition.

ATTACHMENTS

A. The Occurrence and Characteristics of Fluvial Sediment in the Genesee River basin--A Reconnaissance by F. J. Keller and B. K. Gilbert, 1966; U.S. Geol. Survey open-file report, 23 p.

B. Bank Stabilization and Reservoir Sedimentation in the Genesee River Basin by the U.S. Army Engineer District, Buffalo, N. Y., 1966; U.S. Corps of Engineers open-file report, 18 p.

C. Sheet and Channel Erosion in the Uplands (of the Genesee River Basin) by the U.S. Dept. of Agriculture, Soil Conservation Service, Syracuse, N. Y., 1967; open-file report, 6 p.

ATTACHMENT A for APPENDIX K (Sedimentation)

of

GENESEE RIVER BASIN COMPREHENSIVE STUDY

THE OCCURRENCE AND CHARACTERISTICS OF FLUVIAL SEDIMENT IN THE GENESEE RIVER BASIN -- A RECONNAISSANCE

By

F. J. Keller and B. K. Gilbert

Prepared by the

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

in cooperation with the

NEW YORK STATE CONSERVATION DEPARTMENT

DIVISION OF WATER RESOURCES

1967

CONTENTS

ILLUSTRATIONS

TABLES

ABSTRACT

The Genesee River basin contains about 2,500 square miles all of which is in New York except for about 96 square miles which is in northern Pennsylvania.

The average annual sediment discharge of streams in the basin ranges from 75 to 1,100 tons per square mile. Data collected at Avon, the downstream site measured on the Genesee River, indicate that 1.2 million tons of sediment are carried from the basin in an average year. This amounts to about 750 tons for each of the 1,666 square miles upstream.

Sediment discharges are great enough in many locations to be a critical consideration in the evaluation of proposed dams, water-treatment facilities, and other structures affected by streamflow. Bank scour is evident along many stream reaches and causes localized losses of land, but no critical areas of sheet erosion were found. Therefore, at the present stage of development, the most troublesome aspect of sedimentation in the Genesee River basin is deposition rather than erosion.

INTRODUCTION

Fluvial sediment is material that has been transported or deposited by streams and is often thought of as mud or silt. However, it also includes organic debris and material both coarser and finer than silt. The sediment is either suspended in the water or moved along the bottom of streams until finally deposited.

In an average year the Genesee River carries 1.2 million tons of sediment past Avon (this amounts to about 750 tons for each of the 1,666 square miles of drainage area upstream). The material so transported is eroded from both the surrounding land surface and the stream channels in the basin.

Purpose and Scope

The U.S. Geological Survey conducted a study in the basin in 1963-1965 to determine the amount of sediment transported in the Genesee River basin in order to provide data to agencies which are planning the construction, operation, and maintenance of dams, bridges, water-treatment facilities, and other structures that are affected by sediment in streams. It was also desired to identify any locations which might be contributing excessive amounts of sediment so that corrective measures could be taken if necessary and feasible.

Initially, 12 stream-gaging stations were selected as sediment measuring sites on the basis of the size of sub-basin drainage areas, land use, representative soils, and preliminary knowledge as to the locations of prospective damsites. Two more stations were subsequently selected to determine the amount of streambank scour taking place. All 14 locations are shown in figure 1.

The Geological Survey initiated sediment studies in the fall of 1963 and all data were collected between March 1964 and July 1965. During this period the following work was accomplished:

1. An average of 21 suspended-sediment measurements were made at each of the 14 locations.
2. At five locations, suspended-sediment samples were taken for particle-size analysis.
3. A total of 32 point measurements of suspended sediment were made at three locations.
4. Bed-sediment samples were taken for size analysis at each of eight locations.

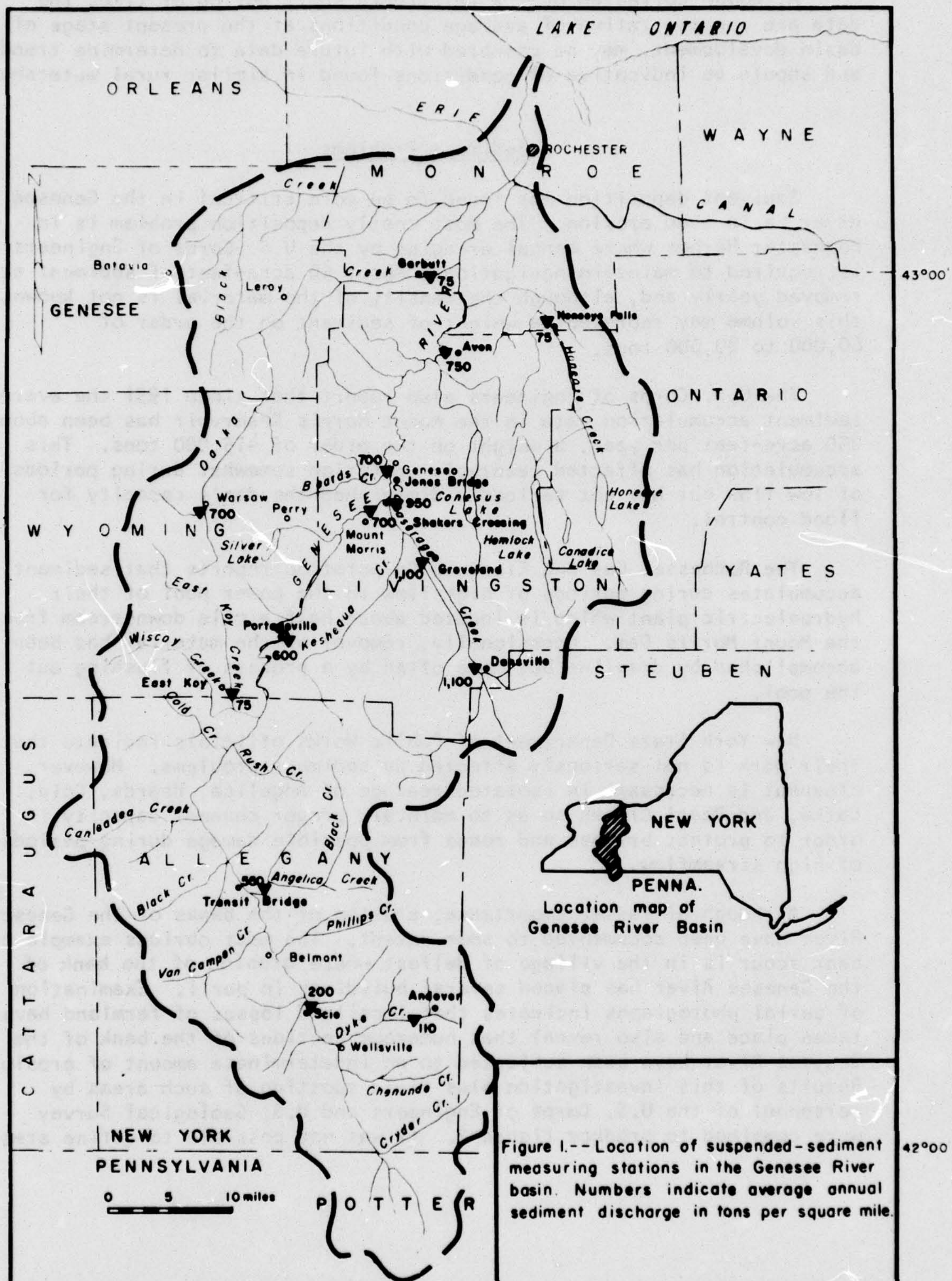


Figure 1.--Location of suspended-sediment measuring stations in the Genesee River basin. Numbers indicate average annual sediment discharge in tons per square mile.

Although collected over a relatively short period of time, the data are representative of average conditions at the present stage of basin development, may be compared with future data to determine trends, and should be indicative of conditions found in similar rural watersheds.

Sediment Problems

Sediment deposition was found to be more critical in the Genesee River basin than erosion. The most costly deposition problem is in Rochester Harbor where annual dredging by the U.S. Corps of Engineers is required to maintain navigation. About 50 acre-feet of sediment are removed yearly and, although the density of the material is not known, this volume may represent a weight of sediment on the order of 60,000 to 80,000 tons.

The U.S. Corps of Engineers also report that since 1951 the average sediment accumulation rate in the Mount Morris Reservoir has been about 250 acre-feet per year, a weight on the order of 415,000 tons. This accumulation has affected reservoir operation somewhat during periods of low flow but has not seriously diminished the dam's capacity for flood control.

The Rochester Gas and Electric Corporation reports that sediment accumulates during periods of high flow in the power pool of their hydroelectric plant which is located about half a mile downstream from the Mount Morris Dam. Occasionally, removal of the material has been accomplished by dragline but more often by a process of flushing out the pool.

New York State Department of Public Works officials indicate that their work is not seriously affected by sediment problems. However, cleanout is necessary in isolated reaches of Angelica, Beards, Cold, Oatka, and Pearl Creeks so as to maintain proper channel capacity in order to protect bridges and roads from possible damage during periods of high streamflow.

Although of lesser importance, erosion of the banks of the Genesee River have been documented to some extent. The most obvious example of bank scour is in the village of Belfast where erosion of the bank of the Genesee River has placed several buildings in peril. Examination of aerial photographs indicates that localized losses of farmland have taken place and also reveal that numerous sections of the bank of the Genesee River have been subjected to an indeterminate amount of erosion. Results of this investigation plus field spotting of such areas by personnel of the U.S. Corps of Engineers and U.S. Geological Survey were combined to produce figure 2. It was not possible to define areas

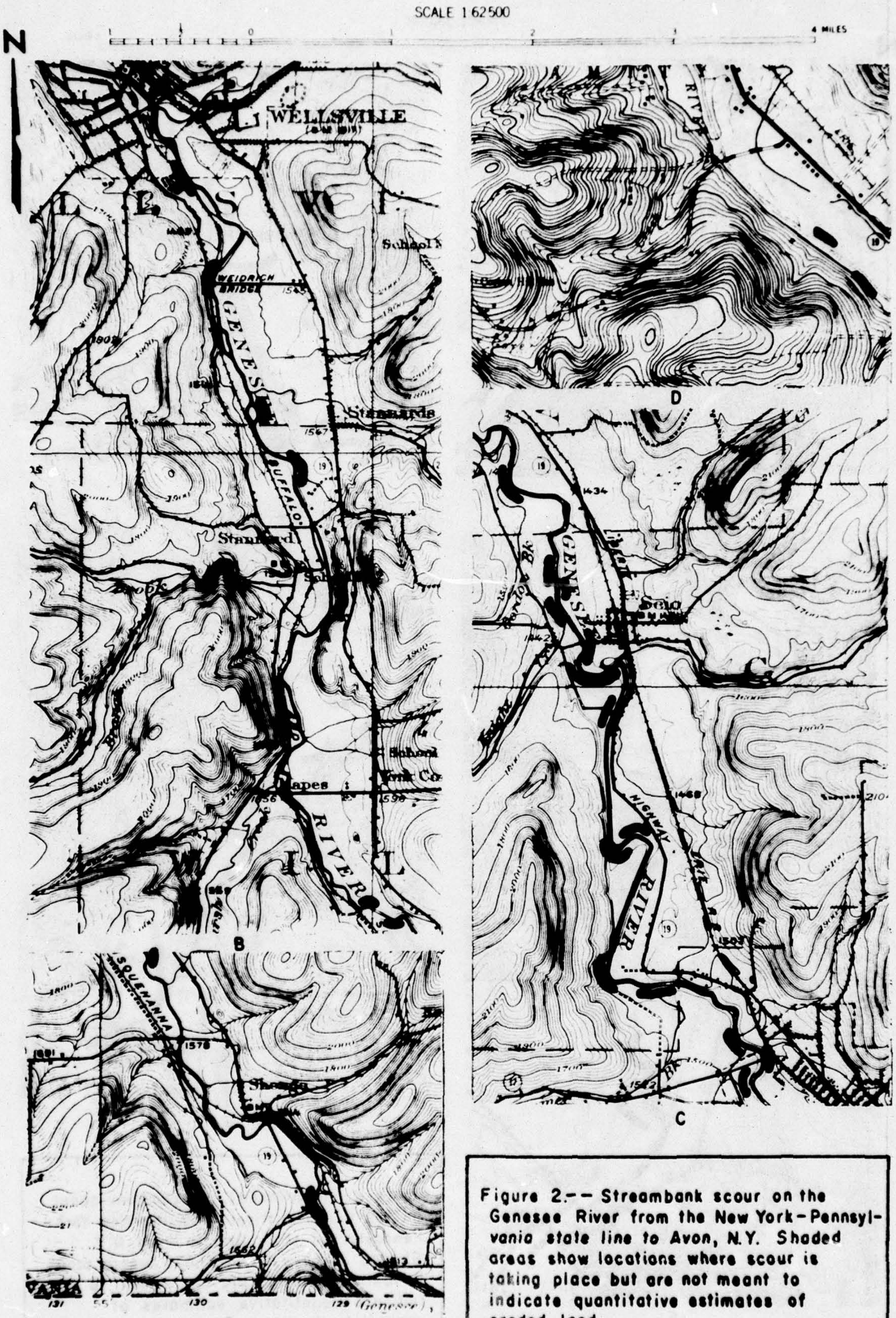
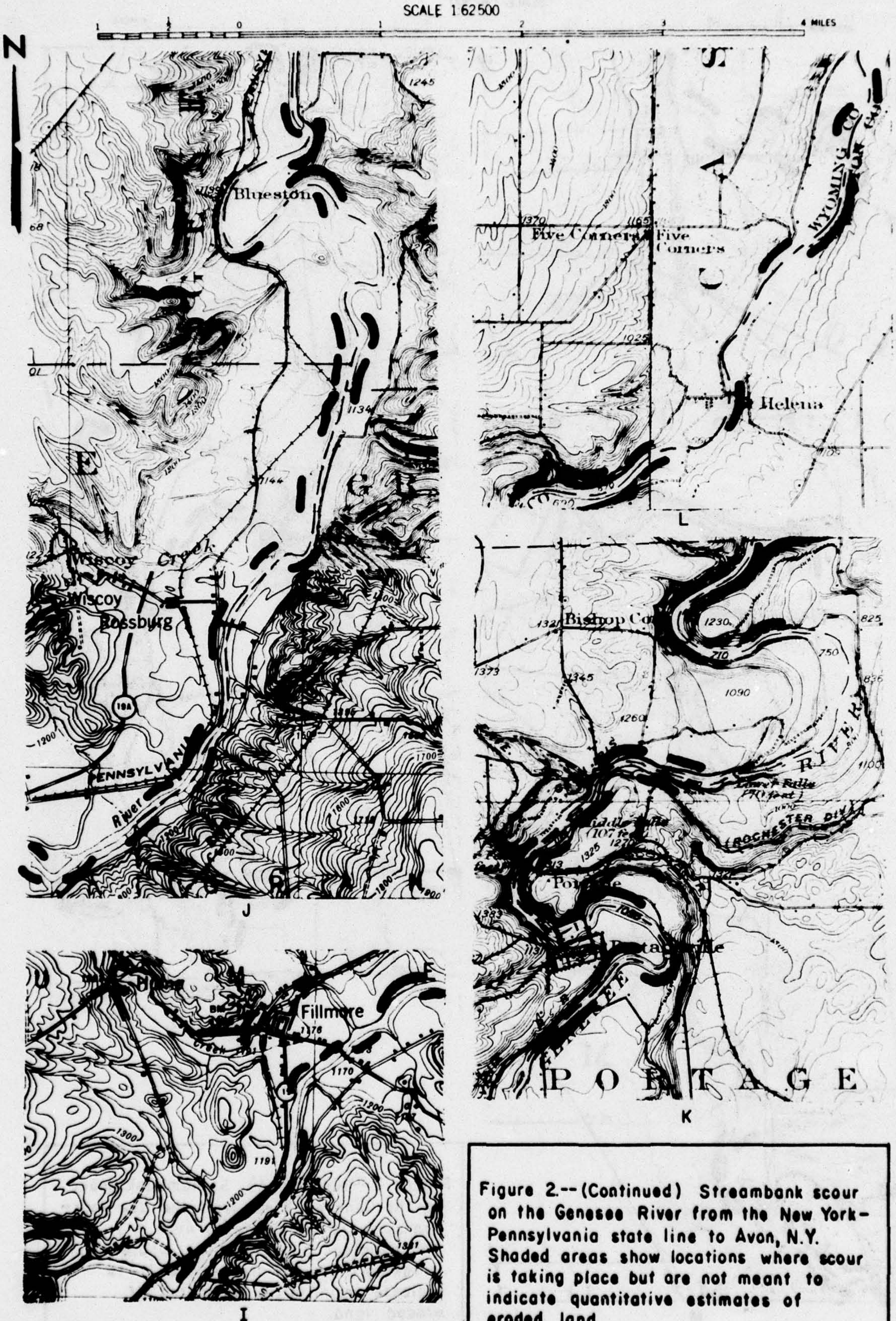


Figure 2.-- Streambank scour on the Genesee River from the New York-Pennsylvania state line to Avon, N.Y. Shaded areas show locations where scour is taking place but are not meant to indicate quantitative estimates of eroded land.

Figure 2.--(Continued) Streambank scour on the Genesee River from the New York-Pennsylvania state line to Avon, N.Y. Shaded areas show locations where scour is taking place but are not meant to indicate quantitative estimates of eroded land



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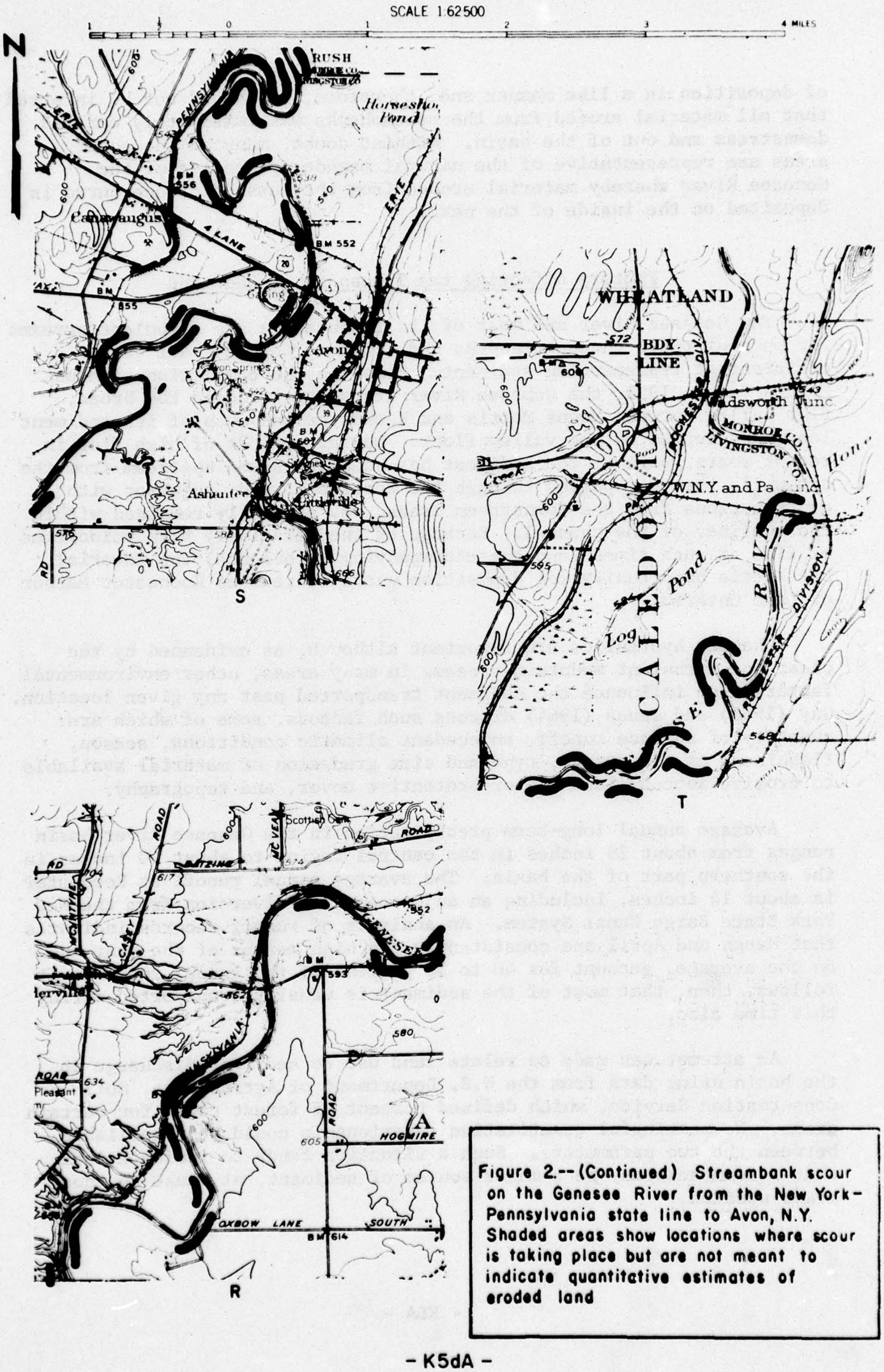

Figure 2.--(Continued) Streambank scour on the Genesee River from the New York–Pennsylvania state line to Avon, N.Y. Shaded areas show locations where scour is taking place but are not meant to indicate quantitative estimates of eroded land

of deposition in a like manner and, therefore, it should not be inferred that all material eroded from the streambanks was immediately carried downstream and out of the basin. Without doubt, many of the scour areas are representative of the natural meander processes of the Genesee River whereby material eroded from the outside of one curve is deposited on the inside of the next.

Factors Affecting the Transport of Sediment

The Genesee River and most of its tributaries are turbulent streams for much of their channel lengths and, in many reaches, are quite efficient at transporting sediment. Prior to the completion of Mount Morris Dam in 1951, the Genesee River frequently flooded the broad, flat valley between Mount Morris and Rochester and much of its sediment load was dropped on the valley floor. During periods of high flow in recent years, part of the sediment has been deposited upstream from the dam while the rest passed through the reservoir, and, together with contributions from the downstream areas, has generally remained within the confines of the channel. Because of the relatively high velocities of flow at such times (and the accompanying turbulence) the material has little opportunity for deposition until it reaches Rochester Harbor or Lake Ontario.

Channel hydraulics are important although, as evidenced by the clear but turbulent mountain streams in many areas, other environmental factors also influence the sediment transported past any given location. Guy (1964) and Jones (1964) discuss such factors, some of which are: quantity of surface runoff, antecedent climatic conditions, season, flashiness of the stream, type and size gradation of material available to erosive forces, land use or protective cover, and topography.

Average annual long-term precipitation in the Genesee River basin ranges from about 29 inches in the central region to about 40 inches in the southern part of the basin. The average annual runoff at Rochester is about 14 inches, including an adjustment for diversion from the New York State Barge Canal System. An analysis of runoff records indicates that March and April are consistently the high months of the year and, on the average, account for 40 to 50 percent of the annual runoff. It follows, then, that most of the sediment is usually transported during this time also.

An attempt was made to relate land use to sediment discharge in the basin using data from the U.S. Department of Agriculture, Soil Conservation Service, which defined percent of forest cover for certain areas. No meaningful quantitative relationship could be established between the two parameters. Such a situation tends to indicate that that streambanks may be a major source of sediment, at least in those areas studied.

Sufficient time was not available to relate the other environmental factors mentioned to the sediment situation in the basin.

Acknowledgments

The authors gratefully acknowledge the help of the U.S. Corps of Engineers, U.S. Soil Conservation Service, U.S. Agricultural Stabilization and Conservation Service, U.S. Forest Service, and the U.S. Weather Bureau in providing assistance and facilities at various times during the course of this study. The study itself has been carried out in cooperation with the New York State Conservation Department, Division of Water Resources.

COMPUTATION OF AVERAGE ANNUAL SEDIMENT DISCHARGE

Sediment discharge was computed from instantaneous measurements of suspended-sediment concentrations plus an allowance for bedload discharges, as will be explained subsequently. Suspended-sediment measurements were made during periods of high streamflow and were related to concurrent water-discharge data obtained from gaging-station records. To arrive at estimates of average annual sediment discharge, this information was related to long-term flow-duration curves which were available for each gaging station. This method was used because it allows appraisal of the sediment characteristics of a rather extensive area in a relatively short time with limited personnel.

Obviously, better definition could be obtained by making daily sediment measurements at each site or by prolonging the study sufficiently to permit measurement of 20 or more separate storm-runoff events. The latter method would allow use of an average sediment concentration for each event which would tend to smooth out some of the irregularities present in the relationship obtained by using results of individual instantaneous measurements.

Method of Computation

The method used to compute sediment discharge in this report requires the definition of a sediment-transport curve as shown in figure 3. This curve results from a plot of the concentration of suspended sediment in a sample against the water discharge of the stream at the time the sample was collected. The sediment-transport curve is used in conjunction with a flow-duration curve for the stream to compute average annual sediment discharge at the site. An example of the computational procedure is shown in table 1.

The first three columns of table 1 are used to list data from a flow-duration curve in tabular form showing interval of time the flow

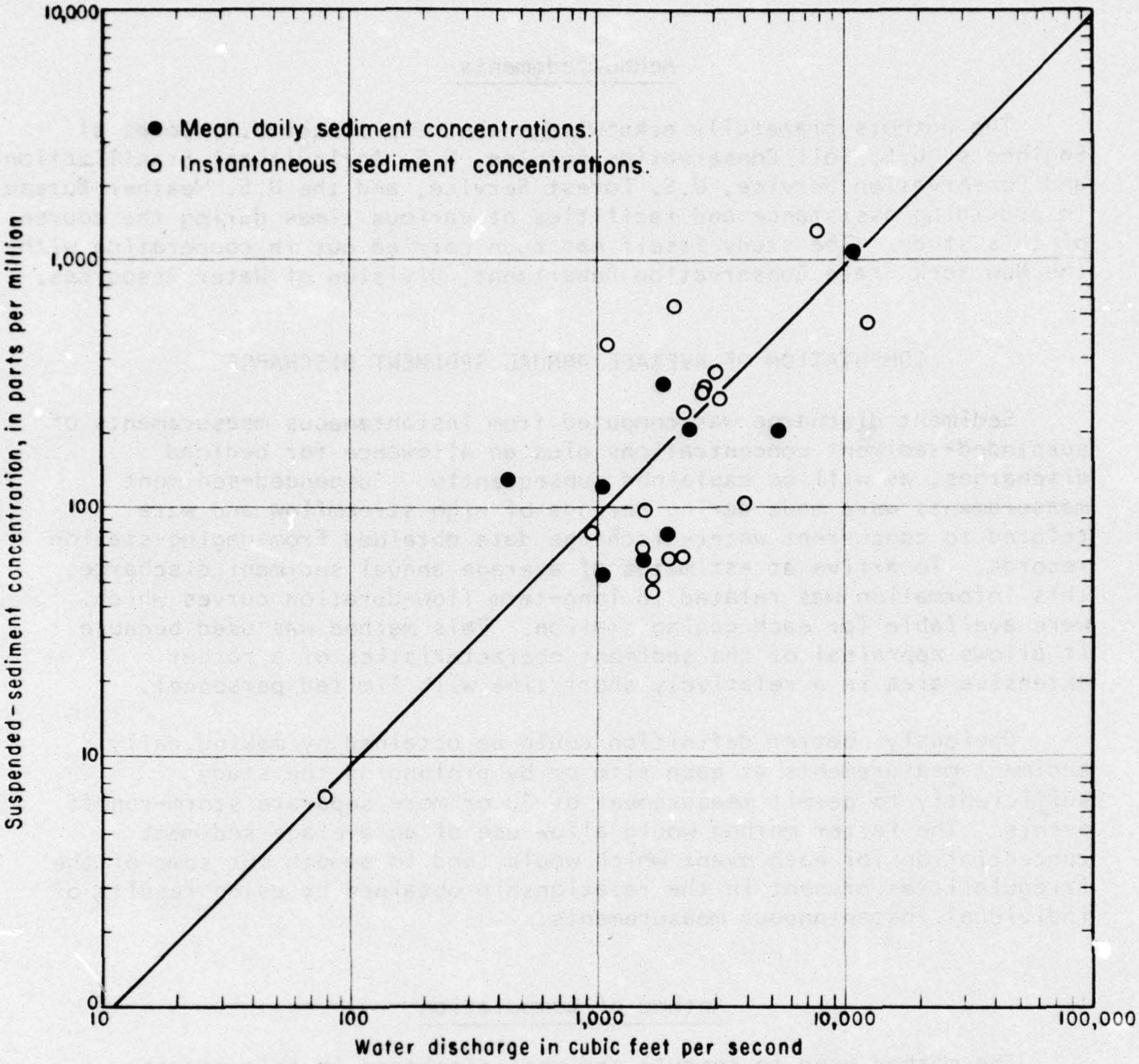

Figure 3.-- Sediment-transport curve for the Genesee River at Scio, N.Y., for the period March 1964 to April 1965.

Table 1.--Computation of average annual sediment discharge for the Genesee River at Scio, N. Y., for the period 1931-60.

1	2	3	4	5	6	7
Subrange of the duration curve (percent limits)	Interval of time (percent)	Midordinate of interval (percent)	Water discharge 1/ (cfs)	Suspended-sediment concentration 2/ (ppm)	Suspended-sediment discharge: Tons/day	Suspended-sediment discharge: Tons/interval of day col. 2 times col. 6
0.0-0.25	0.25	0.125	6,900	660	12,300	31
0.25-0.75	.50	.50	4,400	415	4,940	25
0.75-1.5	.75	1.125	3,200	300	2,600	20
1.5-2.5	1.0	2.0	2,400	225	1,460	15
2.5-4.5	2	3.5	1,800	168	817	16
4.5-8.5	4	6.5	1,300	120	421	17
8.5-15	6.5	11.75	850	79	181	12
15-25	10	20	550	51	76	8
25-35	10	30	360	33	32	3
35-45	10	40	250	23	16	2
45-55	10	50	172	16	7	1
55-75	20	65	99	9	2	0
75-95	20	85	41	4	0	0
95-100	5	97.5	20	1	0	0
Totals	100	Average daily suspended sediment discharge = 150 tons				

Average annual suspended-sediment discharge = 365 x 150 = 54,750 tons

Add estimated 10 percent for bedload . . . . 5,475 tons

Average annual sediment discharge (rounded) . . . . 60,000 tons

1/ From flow-duration curve for the period 1931-60.

2/ From sediment transport curve (Figure 3).

was within each subrange and the midordinate of each subrange. Column 4 lists water discharges that correspond to duration points shown in column 3. From the sediment-transport curve, values for concentration are obtained for each of the water discharges and listed in column 5. For example, from figure 3 a discharge of 3,200 cfs (cubic feet per second) indicates a suspended-sediment concentration of 300 ppm (parts per million). Column 6 shows theoretical average daily suspended-sediment discharges that would occur if the conditions of water discharge and sediment concentration for each subrange persisted for an entire day. These values are derived by multiplication of water discharge (column 4) by suspended-sediment concentration (column 5), and by a constant (0.0027) to keep the units consistent. Results of these computations are then prorated on the basis of the interval of time (column 2) for each subrange of the duration curve and are listed in column 7. A total of the values in column 7 gives average daily suspended-sediment discharge. The final steps include conversion of the daily total to an annual value and the addition of 10 percent as an allowance for bedload to produce an overall estimate of average annual sediment discharge. The 10 percent allowance is discussed in more detail subsequently in this report. Wark and others (1961) indicate that similar estimates have also been used by other investigators.

The Results and their Limitations

Use of the method of computation described above requires assumptions that the flow-duration and sediment-transport curves represent long-term relationships, and that the concentration of suspended sediment in the samples has the same relation to the concurrent water discharge as the daily values of concentration and water discharge would have. Thus, the reliability of the estimates of sediment discharge made in this study is limited by the validity of the assumptions and by the accuracy of the data collected. An evaluation of some of these factors follows.

Satisfactory streamflow data were available from all gaging stations at times of sediment measurements. Flow-duration curves were developed on the basis of analyses of existing long-term (30-year) records for all stations except those having less than 2 years of record. For those stations: Dyke Creek near Andover, Angelica Creek at Transit Bridge, East Koy Creek at East Koy, and Oatka Creek at Warsaw, duration curves were estimated by correlation with the records from the long-term stations.

Unfortunately, during the course of the study, very few storms occurred which were of a magnitude great enough to provide opportunity for the measurement of sediment in the high ranges of flow. Measurements were made during 6 periods of high flow at each of 7 stations, during 5 periods at each of 6 stations, and during 1 period at 1 station.

However, an average of 21 sediment measurements was made at each of the 14 sites and a study made by Linton and Keller under the supervision of Mr. Wark (written communication), indicates that such a number of measurements may produce a fairly accurate relationship between suspended-sediment discharge and water discharge. It is believed that under the particular conditions of this study, the estimates for suspended-sediment discharge should be within the limits of plus or minus 25 percent.

The bedload discharge occurs in a zone which can not be measured by the suspended-sediment sampler because of mechanical limitations of the device. This unmeasured zone extends about half a foot upward from the bottom of a stream. Sediment in this zone includes suspended sediment, some saltation sediment (particles bouncing along but not in continuous contact with the bottom), and some bedload sediment (particles in motion but also in continuous contact with the bottom).

Bedload discharges were calculated for several sites in the basin by using the Schoklitsch and Meyer-Peter formulae as shown below to lend some credence to the estimate made for bedload discharge (an additional allowance of 10 percent of the suspended-sediment discharge).

Schoklitsch formula (Colby and Hembree, 1955, p. 55-57):

$$G = \frac{86.7}{D_{50}^{\frac{1}{2}}} S_e^{1.5} \left(Q - 0.00532 \left[\frac{wD_{50}}{S_e^{4/3}} \right] \right)$$

in which G = discharge of bed material, in pounds per second;

D_{50} = median diameter of the particles, in inches;

S_e = slope of the energy gradient;

w = width of the stream, in feet;

Q = water discharge, in cubic feet per second.

Meyer-Peter formula (personal communication, Robert Apman, U.S. Dept. of Agriculture, Agriculture Research Service):

$$gs^{2/3} = 39.25\, q^{2/3} S - 9.95\, dm;$$

gs = sediment discharge in pounds per second per foot of width of stream bottom;

q = water discharge in cubic feet per second per foot of width;

s = slope of energy gradient;

dm = mean sediment size in feet, where

$$dm = \frac{di\ pi}{100}$$

pi = percent of material in class

di = mean size of fraction.

Bed material samples were collected during periods of low flow and the other parameters were estimated so as to provide data for use with the formulae. Because of this, the results must be considered to be only an indication of actual conditions present during floods. Hubbell and Matejka (1959) discuss other formulae that could also have been used if the data themselves warranted a more intensive analyses. Results of these calculations for bedload discharge ranged from 0 to 11 percent of the suspended load at the sites investigated. Therefore, it is believed that the 10 percent allowance previously used is at least of the correct order of magnitude. Table 2 lists the estimated average annual sediment discharge for each station, maximum measured sediment concentration, land use as percent of woodland cover in the area upstream, and other data.

Data from instantaneous suspended-sediment measurements are not included in this report but are available at the U.S. Geological Survey District Office, Albany, N. Y., and will be published in a separate basic data report.

SEDIMENT CHARACTERISTICS OF STREAMS IN THE GENESEE RIVER BASIN

Variations in Sediment Discharge

Average annual sediment discharge in the basin varied from 75 to 1,100 tons per square mile of drainage area as shown in table 2. Reasons for this wide variation could be discussed by referring to the section in this report entitled, "Factors Affecting the Transport of Sediment," and developing relationships between these factors and the sediment discharges computed for each site. However, such a discussion would seem to be academic without spending an inordinate amount of time in collecting supporting basic data and developing extensive analyses.

Nevertheless, it is known that sediment doesn't necessarily remain in constant motion from the time it is first eroded until finally deposited. Fine particles as well as coarse may be eroded and deposited

Table 2.--Results of sediment discharge computations for the Genesee River basin based on measurements made from March 1964 to April 1965

Station (In downstream order)	Drainage area (sq mi)	Runoff events measured (number)	Measurements made (number)	Average annual sediment discharge (tons/sq mi/yr)	Maximum concentration measured (ppm)	Land use as percent of woodland upstream 1/
Dyke Creek near Andover, N. Y.	37.4	6	14	110	1,700	39
Genesee River at Scio, N. Y.	309	5	17	200	1,330	38
Angelica Creek at Transit Bridge, N. Y.	84.6	6	16	550	3,100	48
East Koy Creek at East Koy, N. Y.	46.2	5	22	75	286	22
Genesee River at Portageville, N. Y.	982	6	22	600	2,940	34
Genesee River at Mount Morris, N. Y.	1,077	6	35	700	2,200	--
Canaseraga Creek near Dansville, N. Y.	153	5	18	1,100	2,880	38
Canaseraga Creek at Groveland, N. Y. 2/	181	1	5	1,100	6,940	--
Canaseraga Creek at Shakers Crossing, N. Y.	333	6	25	950	6,010	28
Genesee River at Jones Bridge near Mount Morris, N. Y.	1,419	6	35	700	3,390	--
Genesee River at Avon, N. Y.	1,666	5	34	750	2,120	--
Honeoye Creek at Honeoye Falls, N. Y.	197	5	18	75	549	20
Oatka Creek at Warsaw, N. Y.	42.4	6	19	700	2,680	22
Oatka Creek at Garbutt, N. Y.	208	5	21	75	230	22

1/ Preliminary data from U.S. Soil Conservation Service.

2/ Measurements discontinued; stream overflowed its banks at very high stages making accurate measurements of water discharge impossible.

many times before reaching a stream. This process also persists in streams and rivers but usually to some lesser degree. Thus, the sediment measured in a stream at any specific site is an indication only of the net loss from the drainage area upstream at the time the measurement is made. This may be implied from the scatter of points in figure 3 which indicates an approximate 10-fold variation of sediment concentrations at any water discharge.

With these points in mind, it is of interest to note from table 2 that the average annual sediment discharge increased in progression downstream from site to site along the Genesee River. The sediment discharge for the stations on Canaseraga Creek remained relatively constant while those for Oatka Creek decreased in a downstream direction. This condition on Oatka Creek probably represents temporary deposition of material between the two measuring sites. Higher flows than those sampled might eventually move such accumulations downstream to the Genesee River.

Concentration of Suspended Sediment

A river-stage graph and the concurrent suspended-sediment concentration curve are shown in figure 4. The hydrograph is from the gaging-station records for the Genesee River at Scio and the concentration curve has been synthesized using data from the suspended-sediment measurements that were made at that site.

It is significant to note in figure 4 that although the concentration curve and the hydrograph both rise and fall, they do not necessarily do so exactly in phase with each other. The concentration curve rises a trifle faster, peaks slightly sooner, and falls noticeably faster than the stream hydrograph. It is desirable to consider this when scheduling suspended-sediment measurements which are to be used to define a concentration curve. Five or fewer well distributed measurements may suffice to secure such definition.

Sediment-concentration curves have been used in this study to compute daily and storm-period sediment loads and to provide inferred data which were used to help develop the sediment transport curves.

The maximum measured sediment concentrations for each site have been listed in table 2. Because of the short duration of peak concentrations, it can be stated that in most cases the actual peaks were somewhat higher than those measured. The concentration measured ranged from 1 to 6,940 ppm (parts per million).

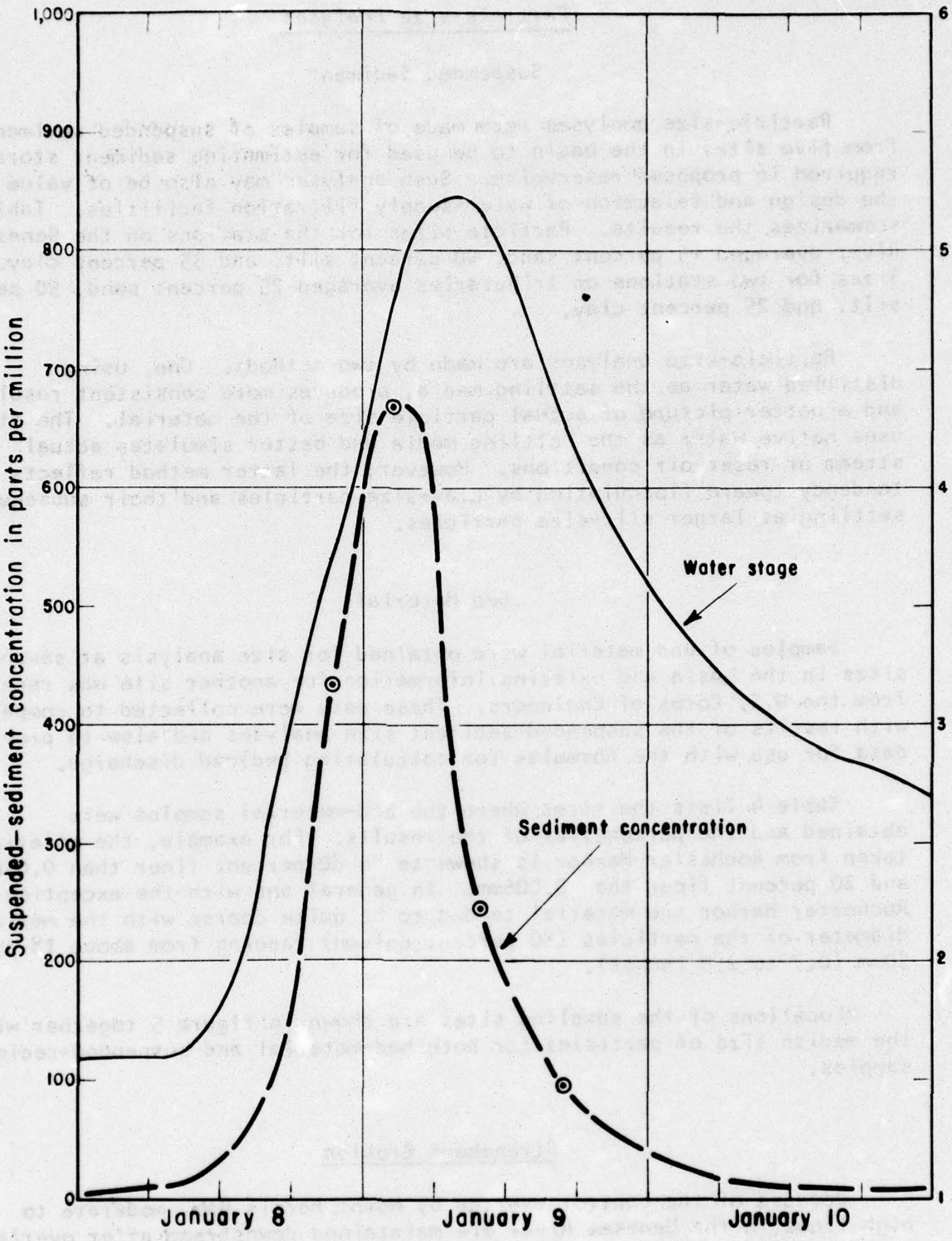

Figure 4.--River-stage graph and concurrent suspended-sediment concentration curve for the Genesee River at Scio, N.Y., for the period January 8-10, 1965

Particle-size Analyses

Suspended Sediment

Particle-size analyses were made of samples of suspended sediment from five sites in the basin to be used for estimating sediment storage required in proposed reservoirs. Such analyses may also be of value in the design and selection of water-supply filtration facilities. Table 3 summarizes the results. Particle sizes for the stations on the Genesee River averaged 15 percent sand, 50 percent silt, and 35 percent clay. Sizes for two stations on tributaries averaged 25 percent sand, 50 percent silt, and 25 percent clay.

Particle-size analyses are made by two methods. One, using distilled water as the settling media, produces more consistent results and a better picture of actual particle size of the material. The other uses native water as the settling media and better simulates actual stream or reservoir conditions. However, the latter method reflects a tendency toward flocculation by clay-size particles and their subsequent settling as larger silt-size particles.

Bed Material

Samples of bed material were obtained for size analysis at seven sites in the basin and existing information for another site was received from the U.S. Corps of Engineers. These data were collected to compare with results of the suspended-sediment size analyses and also to provide data for use with the formulae for calculating bedload discharge.

Table 4 lists the sites where the bed-material samples were obtained and the percentiles of the results. For example, the material taken from Rochester Harbor is shown to be 80 percent finer than 0.05mm and 20 percent finer than 0.006mm. In general and with the exception of Rochester Harbor the material tended to be quite coarse with the median diameter of the particles (50 percent column) ranging from about 18 to 50mm (0.7 to 2.0 inches).

Locations of the sampling sites are shown in figure 5 together with the median size of particles for both bed-material and suspended-sediment samples.

Streambank Erosion

Because of the control exerted by Mount Morris Dam, moderate to high flows in the Genesee River are maintained downstream after overland runoff and high flows in tributaries have subsided. This situation

Table 3.--Summary of particle-size analyses of suspended-sediment samples obtained from March 1964 to April 1965 in the Genesee River basin

(Method of analysis: B, bottom withdrawal method; S, sieved; N, native water used as the settling media; W, distilled water used as the settling media; C, chemically dispersed; M, mechanically dispersed.)

Date of collection	Time (EST)	Discharge (cfs)	Suspended sediment: Percent finer than indicated size, in millimeters										Method of analysis
			clay		silt			sand					
			0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	
			Genesee River at Scio, N. Y.										
4- 7-65	1450	22,800	21	35	45	57	71	82	95	99	100	100	BSWCM
1- 9-65	1040	2,280	42	54	65	77	89	95	99	99	100	100	BSWCM
			Angelica Creek at Transit Bridge, N. Y.										
4- 7-65	1105	1,240	17	30	40	52	66	78	92	98	99	100	BSWCM
4- 7-65	1140	1,240	8	16	28	41	63	75	90	98	100	100	BSN
			Genesee River at Portageville, N. Y.										
3- 6-64	1355	16,800	30	37	47	60	71	84	92	95	99	100	BSWCM
3- 6-64	1355	16,800	14	22	33	45	67	82	91	94	99	100	BSN
1- 9-65	0725	9,280	12	17	28	42	66	85	96	99	100	100	BSN
4- 7-65	1630	9,400	17	28	38	48	64	77	93	99	100	100	BSWCM
			Genesee River at Avon, N. Y.										
2-13-65	1320	8,530	27	38	49	64	81	93	98	100	100	100	BSWCM
2-13-65	1320	8,530	12	19	31	47	81	88	97	99	100	100	BSN
4- 9-65	1500	--	22	31	42	53	67	83	96	99	100	100	BSWCM
			Oatka Creek at Warsaw, N. Y.										
4- 7-65	0940	730	12	19	30	41	51	73	92	98	100	100	BSWCM
4- 7-65	0940	730	4	8	14	23	43	61	82	93	98	99	BSN

Table 4.--Size gradations of bed material sampled at selected sites in the Genesee River basin. For example, for Angelica Creek at Transit Bridge, 10 percent of the sample was finer than 0.5mm and 50 percent was finer than 20mm

Sampling locations in downstream order	Diameter of particles (mm) finer than percent of sample shown			
	Percent			
	10	20	50	80
Genesee River west of York's Corner south of Wellsville, N. Y.	6.2	10.0	25.8	37.0
Angelica Creek at Transit Bridge, N. Y.	.5	3.0	20.0	42.0
Genesee River at Transit Bridge, N. Y.	4.5	16.4	50.0	79.0
Genesee River at Portageville, N. Y.	.5	2.0	17.5	53.0
Genesee River near Mount Morris, N. Y. (upstream from Mount Morris Dam)	.1	1.1	21.0	52.0
Genesee River at Mount Morris, N. Y. (downstream from Mount Morris Dam)	.6	6.3	50.0	73.0
Canaseraga Creek at Shakers Crossing, N. Y.	4.1	8.0	34.0	71.0
Genesee River at Rochester, N. Y. 1/ (Rochester Harbor)	--	.006	.020	.05

1/ Data from U.S. Corps of Engineers excavation summaries.

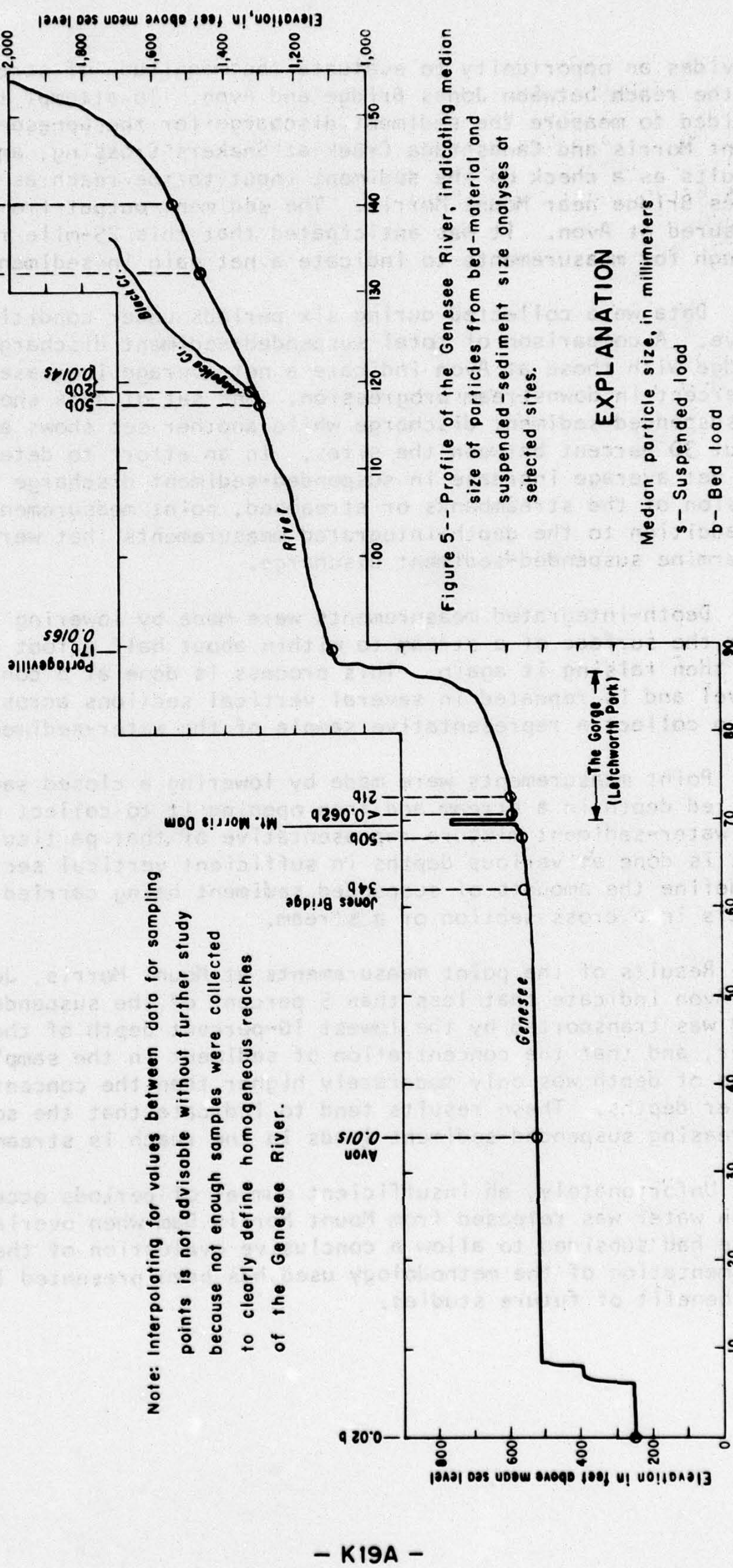

Figure 5.--Profile of the Genesee River, indicating median size of particles from bed-material and suspended-sediment size analyses at selected sites.

provides an opportunity to evaluate the magnitude of streambank erosion in the reach between Jones Bridge and Avon. To attempt this, it was decided to measure the sediment discharge for the Genesee River at Mount Morris and Canaseraga Creek at Shakers Crossing, and combine the results as a check on the sediment input to the reach as measured at Jones Bridge near Mount Morris. The sediment output from the reach was measured at Avon. It was anticipated that this 25-mile reach was long enough for measurements to indicate a net gain in sediment load.

Data were collected during six periods under conditions as outlined above. A comparison of total suspended-sediment discharges at Jones Bridge with those at Avon indicate a net average increase of about 5 percent in downstream progression. One set of data shows a decrease in suspended-sediment discharge while another set shows an increase of about 30 percent between the sites. In an effort to determine whether the net average increase in suspended-sediment discharge was because of erosion of the streambanks or streambed, point measurements were made in addition to the depth-integrated measurements that were made to determine suspended-sediment discharge.

Depth-integrated measurements were made by lowering an open sampler from the surface of a stream to within about half a foot of the bottom and then raising it again. This process is done at a constant rate of travel and is repeated in several vertical sections across a stream so as to collect a representative sample of the water-sediment mixture.

Point measurements were made by lowering a closed sampler to the desired depth in a stream and then opening it to collect a sample of the water-sediment mixture representative of that particular point. This is done at various depths in sufficient vertical sections to try to define the amounts of suspended sediment being carried at different levels in a cross section of a stream.

Results of the point measurements at Mount Morris, Jones Bridge, and Avon indicate that less than 5 percent of the suspended-sediment load was transported by the lowest 10-percent depth of the Genesee River, and that the concentration of sediment in the samples from this range of depth was only moderately higher than the concentration at lesser depths. These results tend to indicate that the source of increasing suspended-sediment loads in the reach is streambank erosion.

Unfortunately, an insufficient number of periods occurred during which water was released from Mount Morris Dam when overland flow elsewhere had subsided to allow a conclusive evaluation of the situation. Documentation of the methodology used has been presented largely for the benefit of future studies.

RESERVOIR SEDIMENTATION

In addition to the sediment discharge of a stream, size gradation of suspended sediment and pattern of operation of a dam must be known to determine the rate at which reservoir storage capacity will decrease because of sediment deposition. If a reservoir is to be used primarily for flood control, a low trap efficiency may be expected and provision for sediment storage might be quite small. If a large permanent pool is to be maintained, trap efficiency would increase and might approach 100 percent, perhaps posing a critical consideration in the evaluation of the proposed site. Formulae have been developed to determine specific volumes of material deposited in reservoirs, including those used for flood control wherein such material may be subjected to periodic wetting and drying (Lane and Koelzer, 1943 and 1959). The formulae require data on size gradation of suspended-sediment such as provided by particle-size analyses. (See pages 16 through 19 of this report.)

Sediment accumulation in selected reservoirs through 1960, in New York and Pennsylvania (Spraberry, 1964), is shown in figure 6 to indicate current conditions in this part of the country. Data for the Mount Morris and Rushford Reservoirs were obtained from the U.S. Corps of Engineers and U.S. Soil Conservation Service, respectively.

The data show that the average annual accumulation of sediment in those reservoirs listed ranges from 0.036 to 0.41 acre-feet per square mile. The annual accumulation in Mount Morris Reservoir was about 0.23 acre-feet (385 tons) per square mile and in Rushford Lake about 0.37 acre-feet (484 tons) per square mile.

SUMMARY AND CONCLUSIONS

Average annual sediment discharges in the Genesee River basin range from 75 to 1,100 tons per square mile of drainage area. In this predominantly rural basin, no critical areas of sheet erosion were found. The most obvious sources of sediment are the streambanks. These observations are substantiated in part because no meaningful correlation could be developed between forest cover and sediment yields.

The major sediment problems are those of deposition rather than erosion. Annual dredging of Rochester Harbor by the U.S. Corps of Engineers is the most significant and costly problem experienced. However, localized losses of farmland and buildings occasionally take place because of streambank erosion.

All findings indicate that the Genesee River and many of its tributaries may carry enough sediment to warrant consideration of sediment in the evaluation of a proposed reservoir site or water-treatment facility.

Map number	Reservoir	Drainage area (square miles)	Average annual sediment accumulation per square mile (acre-feet)	(tons)
1	Pelto Dam on Dean Creek, Tioga County, N. Y.	0.30	0.133	229
2	Pylkas Dam on Dean Creek, Tioga County, N. Y.	1.1	.036	63
3	Mount Morris Reservoir on Genesee River, Livingston County, N. Y.	1,077	2/ .23	385
4	Rushford Lake on Caneadea Creek, Allegany County, N. Y.	60.7	.37	484
5	Orchard Park Reservoir on Pipe Creek, Erie County, N. Y.	1.67	.23	300
6	Tionesta Reservoir on Tionesta Creek, Forest County, Pa.	478	.20	287
7	Mahoning Creek Reservoir on Mahoning Creek, Armstrong County, Pa.	340	.16	227
8	Crooked Creek Reservoir on Crooked Creek, Armstrong County, Pa.	277	.06	88
9	Loyalhanna Reservoir on Loyalhanna Creek, Westmoreland County, Pa.	290	.38	367
10	Bridgeport Reservoir (Upper) on Jacobs Creek, Westmoreland County, Pa.	32.5	.10	1/
11	Youghiogheny River Reservoir on Youghiogheny River, Somerset County, Pa.	434	.34	483
12	Quemahoning Reservoir on Quemahoning Creek, Somerset County, Pa.	92	.38	1/
13	Hinckston Run Reservoir on Hinckston Run, Cambria County, Pa.	10.8	.41	533
14	Salt Lick Reservoir on Salt Lick Run, Cambria County, Pa.	11.9	.22	287

1/ Density data not available to compute these values.
2/ From advance sedimentation surveys, U.S. Army Corps of Engineers.

Note: All data from Spraberry, 1964, unless otherwise noted.

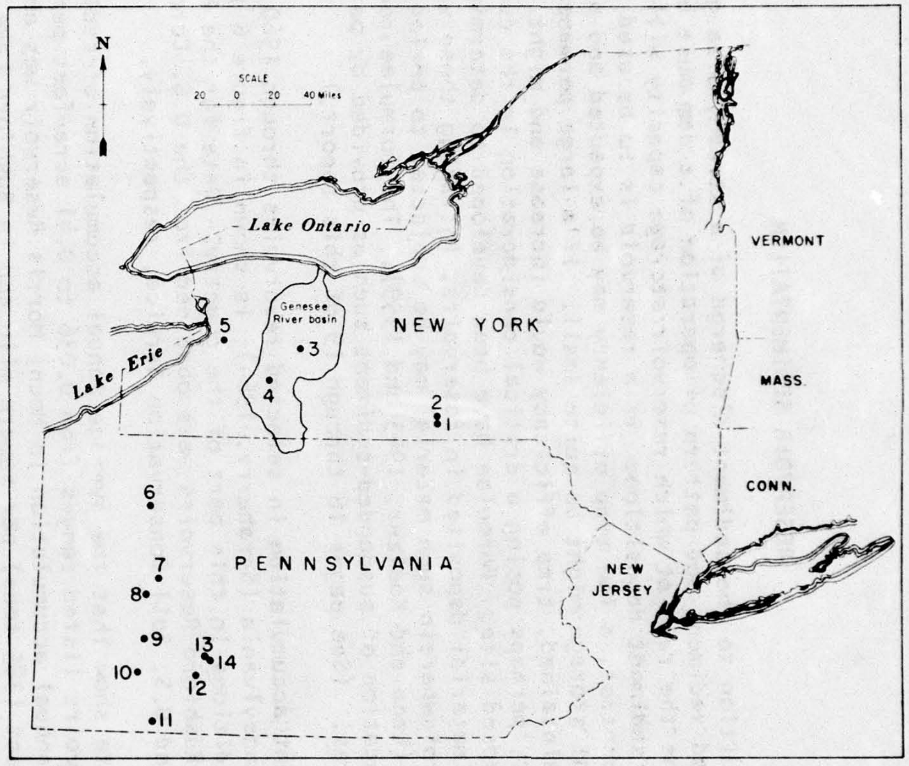

Figure 6--Sediment accumulation in selected reservoirs in New York and Pennsylvania through 1960

REFERENCES

Brune, G. M. 1953, Trap efficiency of reservoirs: Trans. Am. Geophys. Union, v. 34, no. 3.

Colby, B. R., 1956, Relationship of sediment discharge to streamflow: U.S. Geol. Survey open-file rept., 169 p.

Guy, H. P., 1964, An analysis of some storm-period variables affecting stream-sediment transport: U.S. Geol. Survey Prof. Paper 462-E, 46 p.

Hubbell, D. W. and Matejka, D. Q., 1959, Investigation of sediment transportation, Middle Loup River at Dunning, Nebr.: U.S. Geol. Survey Water-Supply Paper 1476, p. 66.

Jones, B. L., 1964, Sedimentation and land use in Corey Creek and Elk Run basins, Pennsylvania 1954-60 (A progress report): Commonwealth of Penn., Dept. of Agr., State Soil and Water Conserv. Comm., open-file rept.

Lane, E. W., and Koelzer, V. A., 1943, A study of methods used in measurements and analysis of sediment loads of streams, density of sediments deposited in reservoirs: U.S. Engineer's Office, St. Paul, Minn., Rept. No. 9.

_______, 1959, Commentary to Report No. 9: Federal-Interagency Sedimentation Proj., 1959.

Miller, C. R., 1951, Analysis of flow duration, sediment rating curve method of computing sediment yield: U.S. Bur. of Reclamation rept.

Parson, D. A., Apmann, R. P., and Decker, G. H., 1964, The determination of sediment yields from flood-water sampling: Internat. Union of Geodesy and Geophysics, Internat. Assoc. of Sci. Hydrology, Berkeley, 1963, p. 7-15.

Spraberry, J. A., 1964, Summary of reservoir sediment deposition surveys made in the United States through 1960: U.S. Dept. of Agr., A.R.S., Misc. Pub. no. 964.

Wark, J. W., Keller, F. J., and Feltz, H. F., 1961, Reconnaissance of sedimentation and chemical quality of surface water in the Potomac River basin: U.S. Corps of Engineers Potomac River Basin Rept., app. H., v. VII.

Wolff, R. G. and Benedict, P. C., 1964, Sedimentology general introduction and definitions, fluvial sediment and channel morphology: U.S. Geol. Survey open-file rept., 129 p.

ATTACHMENT B FOR APPENDIX K (Sedimentation)

of

GENESEE RIVER BASIN COMPREHENSIVE STUDY

BANK STABILIZATION

and

RESERVOIR SEDIMENTATION

Prepared by the
U. S. Army Engineer District, Buffalo
Corps of Engineers
Buffalo, New York 14207

1967

ATTACHMENT B FOR APPENDIX K (**Sedimentation**)

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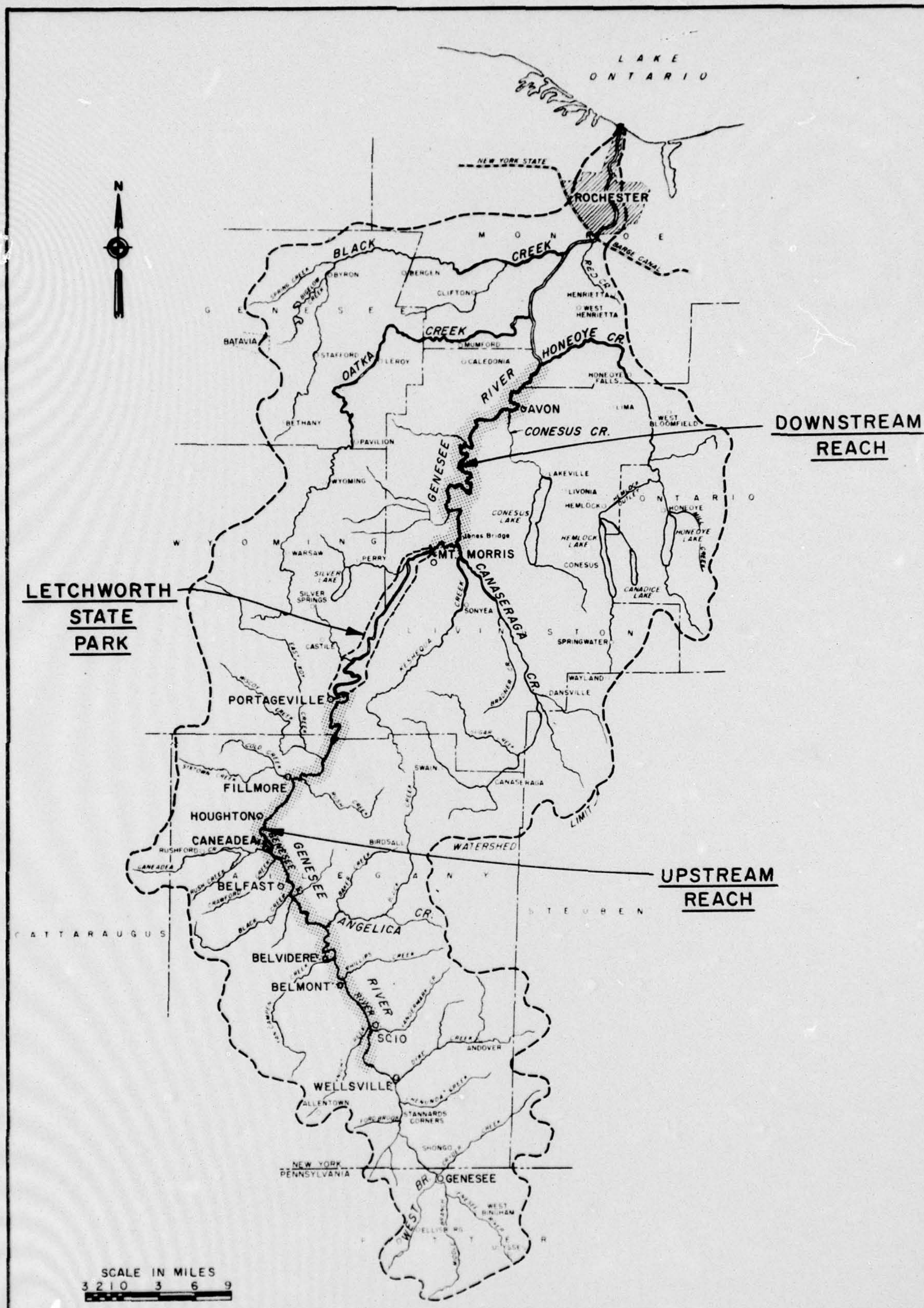


GENESEE RIVER BASIN

(MAIN STEM BANK EROSION STUDY AREAS)

FIGURE 1

INTRODUCTION

Scope

This report is intended to act as an attachment to Appendix K, Sedimentation, and will concentrate on only those sediment effects or remedial measures which are directly related to the main stem or a major tributary of the Genesee River Basin. Upland areas concerned with problems of sheet and channel erosion will be discussed independently by the U.S. Department of Agriculture in their own attachment to Appendix K. The overall sediment appendix is under the auspices of the U.S. Geological Survey, who will compile and summarize these contributing reports, which in turn will constitute one segment of Genesee River Basin comprehensive study.

Geology

The surficial materials overlying the bedrock of the Genesee River Basin consist of till, glacio-fluvial and glacio-lacustrine deposits and alluvium. Till, a mixture of clay, silt, sand, pebbles, and boulders occurs chiefly in ground and terminal moraines. Glacio-fluvial deposits (outwash) ranging from clay to coarse gravel are found mainly in the larger stream valleys. Glacio-lacustrine (glacial lake) deposits are composed chiefly of stratified clay, silt and sand, and are found in valley bottoms formerly occupied by glacial lakes. Alluvium occurs in the present valleys, lakes and swamps.

General Characteristics

The basic elements which will be dealt with in this attachment are the geological processes of erosion and sedimentation. Erosion is the wearing away of soil and rock by the agents of moving water, wind and ice; after these fragments (sediment) are transported to a new location, the resultant accumulation or deposition is sedimentation. Ultimately, when the transporting agent is moving water, all of the sediment passing the mouth of a river consists of material eroded from the land of the drainage basin above, but only part of this eroded material moves continuously and directly from its source to the river mouth. Another part is stored temporarily in point bars, reservoirs, and in the flood plain at various places in the channel system. The resultant deposition or temporary storage on the flood plain results from overbank flows.

In the upper reaches of the Genesee River, many alluvial fans and gravel bars occur, where the steep gradient streams enter the main stem valley. These gravel bars and alluvial fans serve as temporary storage areas; in addition at low and intermediate river stages they also direct the flow of water against river banks causing further undermining and erosion of same. Apparently, the sediment load transported in the

upstream reaches contains a large portion of coarse textured material which it transmitted as bedload during periods of high runoff.

Limited sediment measurements, indicate that the suspended sediment increases substantially below the vicinity of the Angelica Creek confluence on the main stem. The valleys, which are composed of finer textured lacustrine and alluvium deposits, are the source of the increased suspended sediment loads being contributed by the tributaries, with an additional contribution from the main stem river banks.

When comparing the following approximations of sediment loads carried by the Mississippi River with that of the Genesee River, one more fully appreciate the relative quantities of sediment being transported annually by the Genesee.

a. Per square mile of drainage area:

$$\frac{700{,}000{,}000}{1{,}243{,}700} = 563 \text{ tons/sq. mi.} \quad \text{*(@ mouth of Mississippi)}$$

$$\frac{1{,}249{,}500}{1{,}666} = 750 \text{ tons/sq. mi.} \quad \text{** (@Avon on Genesee)}$$

b. Concentration:

$$\frac{700{,}000{,}000}{620{,}000} = 1{,}129 \text{ tons/cfs} \quad \text{*(@ mouth of Mississippi)}$$

$$\frac{1{,}249{,}500}{1{,}860} = 672 \text{ tons/cfs} \quad \text{**(@Avon on Genesee)}$$

*Figures include bedload.
**This figure represents only about 67% of the Genesee River Basin drainage area.

Problems

An appraisal of the quantity and character of sediment transported by streams within the Genesee River Basin is an essential part of comprehensive river basin planning. Where stream measurements reveal excessive amounts of sediment are being transported, and no attempt is made to control erosion, the resultant problems are numerous. An example of sediment related problems are, lower or more costly farm production through loss of fertile lands, continuous dredging of river channels to maintain proper depths for commercial and recreational craft, additional treatment facilities required to obtain potable water, and the degradation of fish and wildlife habitat, to mention but a few.

Feasible Solutions

There are many feasible solutions to the various problems resulting from erosion and sedimentation, but not all these corrective measures would be economically justified, especially in so far as expenditure of Federal funds are concerned. However, where this it true, it is hoped

that sufficient information has been presented in this appendix and attachments to be instrumental in promoting action by local government and individuals.

These feasible solutions or remedial measures discussed in Appendix K, may be broken into two major categories. First, those various methods prescribed to prevent erosion of material from the land of the Genesee River drainage area. This would involve application of basic soil conservation measures and practices on cropland and pastureland and programs for forest conservation. (For additional details, refer to Appendix J, "Agriculture Studies"). These practices and measures in addition to protecting the soil will reduce the sediment load and thus extend the life of flood retarding structures and reservoirs and aid in the enhancement of the streams.

The second category discussed by this attachment, involves remedial work to prevent erosion of streambanks, streambeds and overbank sediment conditions. This category will also include sedimentation effects on reservoirs and possible degradation of streambanks downstream of dam sites. To be designated in this attachment are the following:

1. Areas along the Genesee main stem requiring further detailed investigations.

2. Specific reaches which should receive consideration as a part of proposed multi-purpose projects or plans recommended during the formulation stages of the comprehensive study.

BANK STABILIZATION

Bank Erosion

Failure of river banks results from conditions within and without. Eddy action and some wave wash of the flowing water directly attack the riverside of the banks, while seepage caused by drainage after heavy rains or by a falling river stage, carry particles through the banks causing them to disintegrate. Additional damage may be caused by accumulation of drift which will increase velocities in the immediate vicinity and promote local scour. Bank erosion of the concave bank and deposition on the convex bank both tend to be the greatest just downstream from the position of maximum curvature.

There are associated processes and factors which should be considered with bank erosion for stable channel design. One such process is lateral migration of streams. Stream movement involves little change in channel width while the volume of material eroded from one bank is roughly equal to the volume deposited on the opposite point bar. However, there is a gradual migration of material downstream. Together the processes of erosion and deposition tend to maintain a constant channel width during lateral shifts of the channel. Material eroded from the overall drainage basin is temporarily stored on the flood plain through overbank deposition and in point bars.

The purpose in discussing the above factors, is to emphasize the need for considering the stream as a whole, pattern and total sediment load. The construction of protective or control structures at any location will change the natural regimen of the river. It is possible to eliminate one problem area but create a new one. On the other hand, the river may be induced to solve some of its own problems by promoting aggradation and degradation at desired locations.

Problem Areas

Bank erosion, on the main stem of the Genesee River, occurs in a 110 mile reach which extends from approximately Honeoye Creek confluence upstream to the vicinity of Scio. Estimates were made from aerial photographs which roughly indicate the acreage which has been eroded in this 110 mile reach.

As an initial step in determining the extent of damages caused by bank erosion on the main stem, the above reach was broken into the following segments:

1. Honeoye Creek confluence to Mount Morris, a 40 mile reach below Mount Morris dam

2. Mount Morris to Portageville, a 17 mile gorge through Letchworth State Park

3. Portageville to Scio, a 45 mile reach upstream of the Letchworth gorge

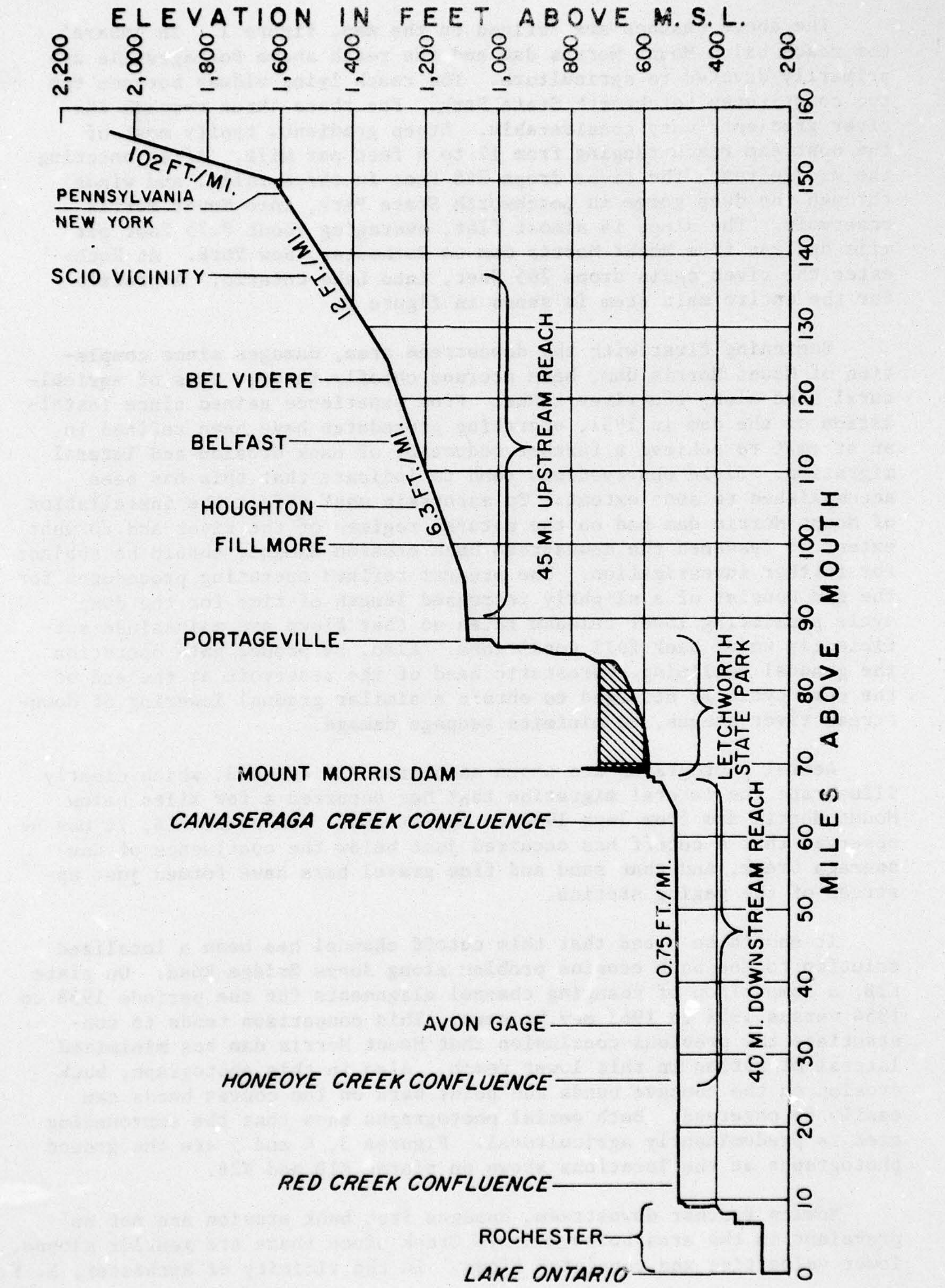
The above reaches are defined on the map, figure 1. In general, the reach below Mount Morris dam and the reach above Portageville are primarily devoted to agriculture. The reach lying midway between the two constitutes Letchworth State Park. For these three reaches the river gradients vary considerably. Steep gradients typify most of the upstream reach ranging from 12 to 6 feet per mile. After entering the middle reach the river drops 248 feet in three falls, and winds through the deep gorge in Letchworth State Park, into Mount Morris reservoir. The slope is almost flat, averaging about 0.75 foot per mile or less from Mount Morris dam to Rochester, New York. At Rochester the river again drops 265 feet, into Lake Ontario. A profile for the entire main stem is shown in figure 2.

Beginning first with the downstream area, damages since completion of Mount Morris dam, have accrued chiefly through loss of agricultural land along the river banks. From experience gained since installation of the dam in 1951, operating procedures have been refined in an attempt to achieve a further reduction of bank erosion and lateral migration. Field observations tend to indicate that this has been accomplished to some extent. To ascertain what effect the installation of Mount Morris dam had on the natural regimen of the river and to what extent it lessened the downstream bank erosion damage, should be subject for further investigation. The present refined operating procedures for the dam consist of a slightly increased length of time for the dump cycle permitting lower release rates so that flows are maintained sufficiently under bank full conditions. Also, by proper gate operation the gradual declining hydrostatic head of the reservoir at the end of the dump cycle is utilized to obtain a similar gradual lowering of downstream river stages, to minimize seepage damage.

Aerial photographs are shown as plates K1B and K2B, which clearly illustrate the lateral migration that has occurred a few miles below Mount Morris dam from June 1938 to August 1954. On plate K1B, it may be observed that a cutoff has occurred just below the confluence of Canaseraga Creek, and that sand and fine gravel bars have formed just upstream of the gaging station.

It should be noted that this cutoff channel has been a localized solution to the bank erosion problem along Jones Bridge Road. On plate K2B, a comparison of changing channel alignments for the periods 1938 to 1954 versus 1954 to 1963 may be seen. This comparison tends to substantiate the previous conclusion that Mount Morris dam has minimized lateral migration in this lower reach. Also in this photograph, bank erosion on the concave bends and point bars on the convex bends can easily be observed. Both aerial photographs show that the surrounding area is predominantly agricultural. Figures 3, 4 and 5 are the ground photographs at the locations shown on plates K1B and K2B.

Moving further downstream, damages from bank erosion are not as prevalent in the area below Honeoye Creek since there are gentler slopes, lower velocities and regulated flows. In the vicinity of Rochester, N. Y.,



MAIN STEM PROFILE

K6B

FIGURE 2

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GENESEE RIVER BASIN COMPREHENSIVE STUDY OF WATER AND RELATED LA--ETC(U)
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Photo No. K1. View downstream from route #20 A bridge. Rip-rap in foreground is protection for the right bridge abutment and the erosion in the background is typical of unprotected banks along the lower Genesee River. Photo was taken in April 1963.

Photo No. K2. View downstream along the left bank, outside bend, of the Genesee River about 0.5 mile above route #20 A bridge. The vertical river bank is typical of many sharp outside bends in the agricultural areas along the river. Photo was taken in January 1956.

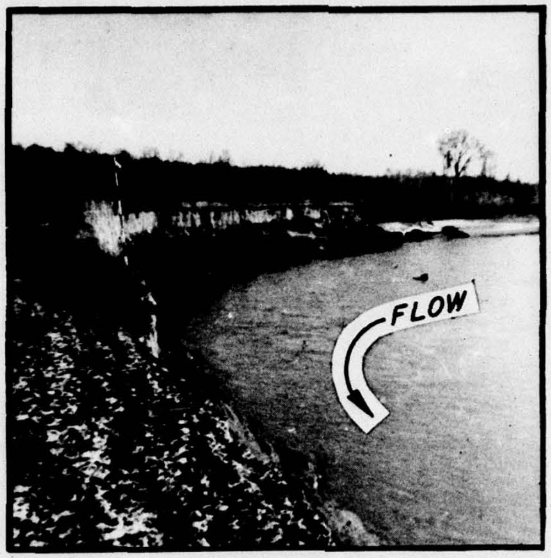


Photo No. K3. View upstream along the right bank, outside bend, of the Genesee River about 0.8 mile above route #20 A bridge. In the background the bank is vertical and in the foreground the top edge indicates that the bank has eroded into a previously cultivated field. Photo was taken in April 1963.

Photo No. K4. View downstream along the top of an outside bend illustrating the type of bank erosion, a section of previously cultivated field about to break-off, which occurs in the steep or vertical bank reaches along the Genesee River. Photo was taken in January 1956.

FIGURE 4

Photo No. K5. View upstream along the left bank in the vicinity of Jones Road and Dutch Corners Road. In the foreground the river has formed almost a right angle outside bend. There has been considerable river alinement change and farmland erosion in this area as shown on plate K2B. Photo was taken in January 1956.

Photo No. K6. View downstream along the same river bend as shown in photo K5.

FIGURE 5

some damage is caused by the Genesee main stem in conjunction with the tributaries of Black Creek to the west and Red Creek to the east. However, bank erosion damage is minor in comparison to overbank conditions which inundate some residential property in the Black Creek area while considerable residential and commercial properties are flooded in the Red Creek area. Problems in the Red Creek area were studied as an interim report to the comprehensive study.

Proceeding next to the middle reach, estimates of main stem bank erosion indicate that reaches above and below Letchworth State Park suffer similar losses of farmland, but the park area,which is only 20 river miles in length, sustains a greater loss than either of the other two. An important feature to be considered at Letchworth State Park is that the river lies in a 17 mile gorge averaging better than 500 feet deep in some areas, while the agricultural areas have banks which normally range from 4 to 8 feet in height. In addition to the limitation of extremely high banks to protect, any proposed measures must not detract from the scenic aspects of the park. So even though the volume of land loss is greater, comparatively speaking, sufficient benefits are not available to satisfy any extensive remedial measures.

In the uncontrolled reach of the main stem upstream of Mount Morris Dam, stream bank erosion is complicated by the addition of overbank flows causing flood plain scour and various other types of flood losses. Major problems in the upstream area attributable to bank erosion are loss of agricultural land, railroad embankments, highway and bridge fills. Both the villages of Belfast and Houghton have some riverside buildings which are threatened by the river if measures are not taken to stabilize the eroding banks. This problem at Belfast is illustrated by a photograph, figure 6. Major upstream structures on the main stem being threatened consist of several homes, a gas station, motel, cemetery and a few bridges. Some temporary measures taken at a local level to retard lateral migration consisted of dumping tree stumps, derrick stone and old car bodies on eroding banks, figure 6. The sediment load on the upper main stem of the Genesee River appears to increase from an annual figure of 200 tons per square mile at Scio, to about 600 tons per square mile at Portageville. For data from particle size analyses refer to figure 5 and tables 3 and 4 in Attachment A by the U. S. Geological Survey.

A strip map, plate K3B, has been prepared on which changes in stream regimen have been noted through comparison of recent quad maps with their earlier counterparts. In three areas, it appears that natural cutoff channels have occurred, one each about a mile above and below Transit Bridge lying between Belfast and Belvidere, the third just below Caneadea. The river apparently in an effort to maintain its natural alinement and gradient has cut laterally into the banks creating major trouble spots below each cutoff at the villages of Belfast and Houghton.

<u>Public Hearing</u>

Preliminary hearings were held at Rochester and Wellsville, New York, 18 and 19 June 1963, respectively. The objective of these hearings was to

Photo No. K7. Bank erosion on an outside river bend along New York route #19, just south of the village of Belfast which is seriously endangering a house and barn. The State of New York is planning bank stabilization work in this area to protect route #19. Photo was taken in May 1966. Areas of proposed State work and location of photos K7 and K8, shown on plate K3B.

Photo No. K8. An unsuccessful local remedial measure to protect the right abutment of the Oramel Hill Road bridge with derrick stone. Addition bank protection, tree stumps and old car bodies can be observed a short distance upstream. Photo was taken in September 1964.

FIGURE 6

afford local governments and individuals the opportunity to comment and make suggestions concerning the needs of the Genesee River Basin. The majority of statements presented by local interests at the Wellsville hearing indicated that serious consideration should be given to the flood hazard and bank erosion in the basin. These statements were supported with photographs and gave some indication of damages to local bank protection, acres of farmland loss and overbank flood damage.

Remedial Structures

Channel protection consists of both an underwater and an upper bank portion. The two basic types of structures used to control, develop and improve open river channels are dike or groin and revetment. In actual use, there are many variations and combinations of these two types.

For flow control different types of dikes or groins are:

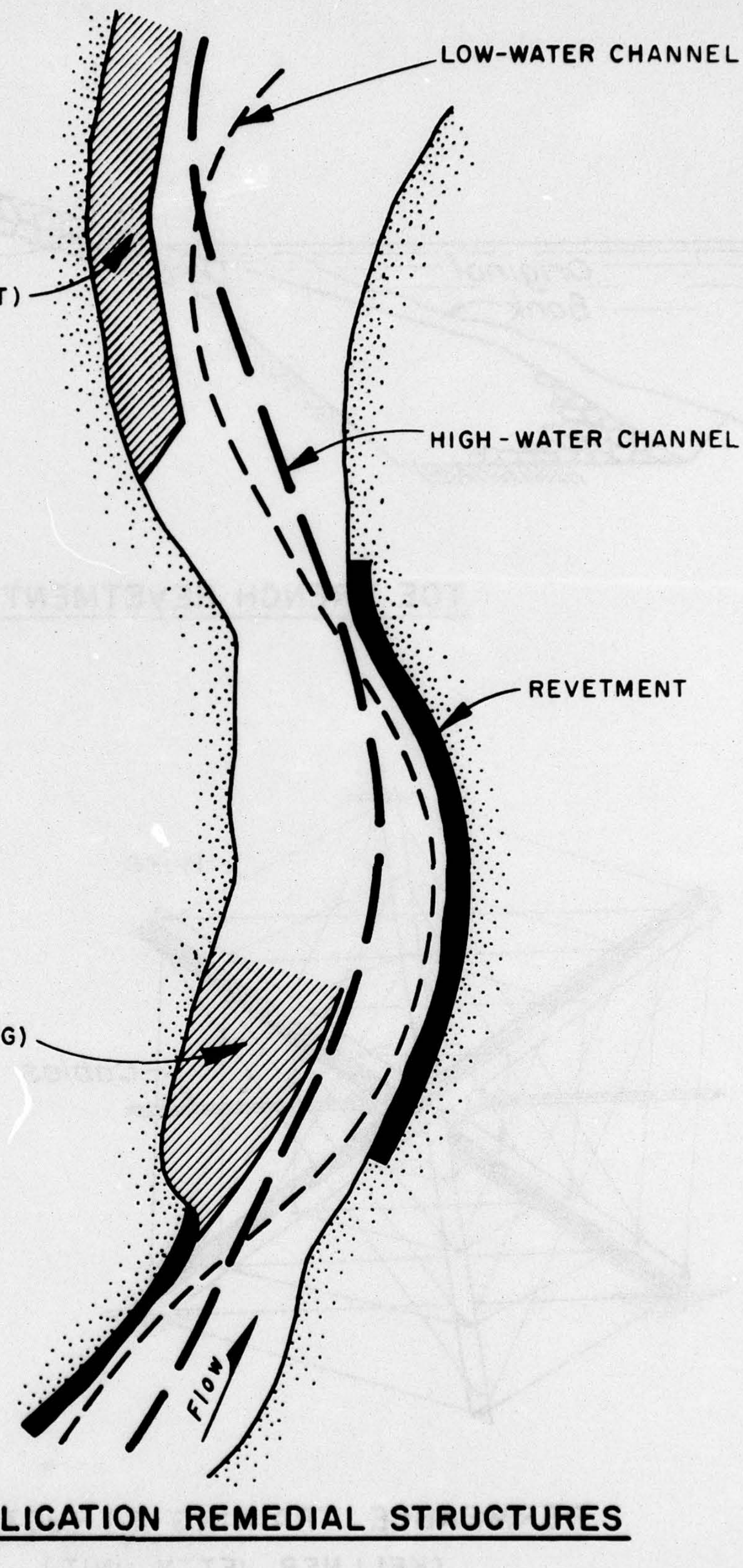
1. Pile with a foundation mattress;
2. Stone filled;
3. Combination pile and stone fill;
4. Crib with or without a foundation mattress;
5. Chute closure;
6. Kellner jetty; and
7. Various forms of retards.

Their function is to direct and guide the flow, retard erosion, and develop accretion.

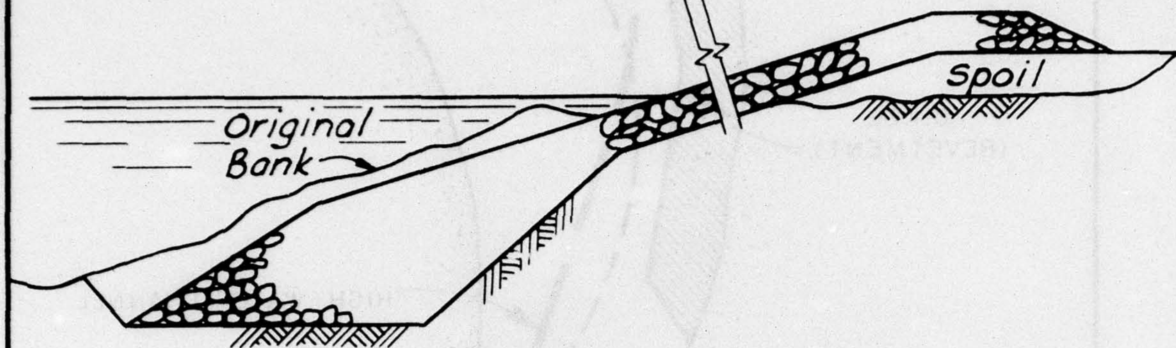
Different types of revetment are:

1. Standard upper bank protection (gravel on flat slopes, hand placed stone, penetration asphalt, bituminous plant mix, sand-cement grouted gravel and dumped stone);
2. Foundation mattress; and
3. Kellner jetties.

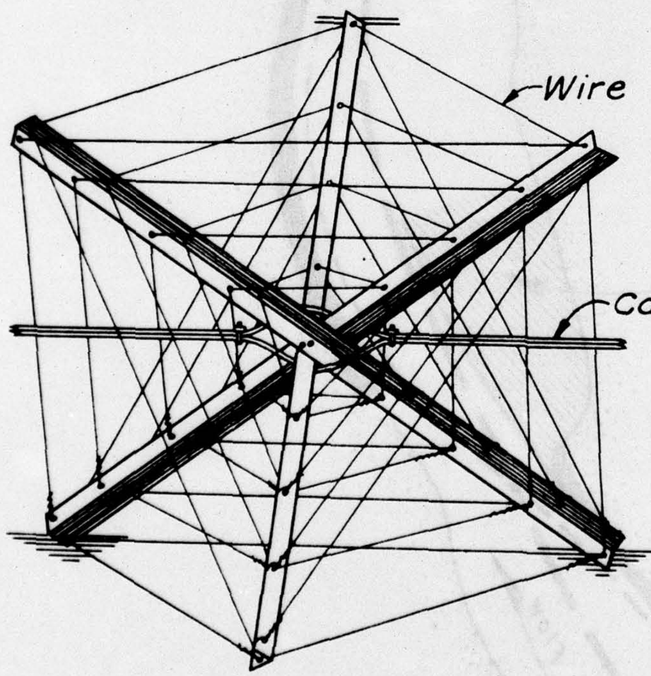
The function of revetment is to stabilize the riverbank in a fixed position, guide and direct the flow, retard erosion, and develop accretion and bank buildup. An illustration of the use of the two basic types of structures are shown in figure 7. Shown in figure 8 are typical sections of two types of remedial structures commonly employed in river stabilization work. The toe trench revetment in figure 8 will be the basis for



APPLICATION REMEDIAL STRUCTURES



TOE TRENCH REVETMENT



PERMEABLE TRAINING STRUCTURE
(KELLNER JETTY UNIT)

developing generalized estimates in the subsequent paragraph. Also in the same figure is an illustration of a Kellner type unit or jack which in actual practice could be used in combination with revetment and various types of dikes. This is a permeable type structure whose primary purpose is to both guide the flow to some desired alinement and to induce sedimentation at a desired location. These jacks are connected together to form a jetty field. The fields are laid out using two types of lines of jetties, a diversion line and retard line (tieback). Diversion lines are roughly parallel to the bank while the retard lines extend at an angle of approximately 67 degrees from the diversion line back to the bank.

However, regardless of the type structure used for bank stabilization, an essential requirement is to consider the regimen of the river as a whole or start the remedial work at some stabilized point upstream and work progressively downstream to some other stable location or to a point that can safely be left uncontrolled.

Basin Economics

The primary basis for determining project feasibility hinges on the estimates of acres lost through bank erosion. These estimates covering a 9-year period through 1963 indicated a total of about 400 acres were lost along the main stem from the Honeye Creek confluence to the vicinity of Scio, see figure 1. When subtracting out the middle portion of the main stem lying within Letchworth State Park, estimates for the agricultural areas remaining indicate a loss due to bank erosion for the 9-year period of 120 acres downstream and 100 acres upstream of the park. These estimates include no loss due to overbank flows.

For project feasibility studies, primary net benefits were used which reflect only a single purpose bank stabilization project with no overbank or flood damages included. Specifically, those benefits accruing to land owners from reduction in the loss of net income (crop production), also a value for loss land and for the elimination of periodic local investments necessary for repair of structures damaged by bank erosion, tables K1B and K2B.

Consideration was given to several types and combinations of dikes and revetment, but because of the sketchy information available, a generalized estimate was made based on using a toe trench type of revetment throughout. Refer to the typical section illustrated in figure 8 for toe trench revetment. Estimates of cost provide revetment for 50% of the upstream and downstream reaches, which was assumed sufficient to provide a complete bank stabilization program for the main stem in the area previously indicated. It is realized that for a detailed analyses of these reaches, the actual linear feet of revetment would probably be less, since dikes would be used in combination with them. Engineering, design, supervision and administration costs were assumed to offset

secondary benefits. Although the estimates are generalized, they do provide a basis for determining the feasibility of a single purpose bank stabilization project along the upstream and downstream reaches of the main stem.

Table K1B shows the major items considered in developing estimates of the total damages and costs for a 50 year period through 2020. Shown in table K2B are the results of dividing those total figures by 50 to obtain average annual values. As is illustrated by table K2B, the project is not economically justified on a single purpose basis. A more favorable project is obtained by the addition of flood prevention as a project prupose. To gain protection against overbank flows, in the upstream reach, requires doubling the project cost while more than tripling the benefits. This results in a benefit-cost ratio of about 0.5, but still does not constitute a basis for a more detailed analyses. It is quite apparent that an economical project for the entire upstream or downstream reach does not exist.

TABLE K1B - Estimated Damages and Project Costs
(50 year prevention period)

Damages/Cost	Downstream Quantity	Downstream Unit	Downstream Unit Price[1] ($)	Downstream Amount ($)	Upstream Quantity[1]	Upstream Unit	Upstream Price ($)	Upstream Amount ($)
Damages								
Bottomland Value	660	Acre	225	149,000	560	Acre	200	112,000
Production	660	Acre	50	33,000	560	Acre	50	28,000
Structures, Misc[2]					-	L.S.	-	100,000
Local Protection Maintenance[3]	-	L.S.	-	250,000	-	L.S.	-	800,000
Total Damages[4]	-	-	-	432,000	-	-	-	1,040,000
Costs								
Investment[5]	227,000	L.F.	12	2,725,000	238,000	L.F.	12	2,856,000
Interest & Amortization	-	-	-	108,000	-	-	-	114,000
Operation & Maintenance (2%)	-	-	-	2,725,000	-	-	-	2,856,000
Total Costs	-	-	-	5,558,000	-	-	-	5,826,000

Footnotes:

1. Figures take into account increased values for 50 year period.
2. Types of structures included are motel, gas station, cemetery and several residential homes.
3. Figure includes damage to or loss of local protection.
4. Estimates include only bank erosion damage.
5. Considered the average bank height as 6 ft.

TABLE K2B. - Project Feasibility[1]

(50 year project life)

Annual Benefits/Costs	Downstream	Upstream
Benefits		
Bottom land Value	$ 3,000	$ 2,200
Production	700	600
Structures, Misc.	-----	2,000
Local Protection & Maintenance	5,000	16,000
Total Annual Benefits	$ 8,700	$ 20,800
Costs		
Investment	$ 54,500	$ 57,100
Interest & Amortization	2,200	2,300
Operation & Maintenance	54,500	57,100
Total Annual Costs	$ 111,200	$116,500
B/C Ratio	0.08	0.18

Footnote:

1. Annual figures obtained by dividing Table 1 values by project life.

Recommendations

The above analyses does not eliminate the possibility for an economically feasible project on a lesser scale at isolated areas along the main stem of the Genesee, and possibly one or two of the tributaries. Recommendations are for further detailed studies in the specific locality of the town of Scio and vicinity, where it would appear that a bank stabilization project, including flood prevention as one of its major purposes, might be justified. Figure 9 illustrates the erosion problem in the town of Scio. One last look should be given to a dual purpose project for the whole upstream reach, giving further consideration to alternate types of revetment or combinations of dikes and revetments that might possibly reduce the project costs. If a more favorable benefit-cost ratio can be obtained, the overall benefits should be re-assessed in more detail. Additional consideration should also be given to isolated areas further downstream from Scio, near the villages of Belfast, Houghton and Fillmore.

In any case these further detailed studies should be deferred pending the outcome of the basin project and plan formulation as the installation of any main stem dams now being considered will greatly alter the prevailing conditions. In some cases the existing problems would be flooded out, and in other instances, controlled releases would virtually eliminate damages due to overbank flows and reduce bank erosion.

Photo No. K9. View upstream on the Genesee River in the town of Scio illustrating the effects of high river stage on the bank and nearby property. Photo was taken on 14 April 1948. The daily average flow at the U.S.G.S. Scio gage for that day was 3,880 cfs with a peak flow of 5,620 cfs recorded at 4:45 P.M. The peak stage was 8.1 foot and official U.S.W.B. flood stage is 8.0 foot.

Photo No. K10. View upstream on the Genesee at the same location as photo K9. Observe the garage and some trees are missing. The photo was taken in the spring of 1951.

FIGURE 9

RESERVOIR SEDIMENTATION

General

The affect of sedimentation on reservoir capacity is one key to determining the useful life of the structure. In order to estimate the amount of storage which will be lost due to sedimentation, the trap efficiency of the structure is determined. Expressed simply, the trap efficiency is the difference of the sediment inflow minus sediment outflow. These evaluations of lost storage capacity should ultimately include a study of where in the reservoir deposition will occur and the volume a given quantity will occupy.

In estimating the trap efficiency of a particular structure, consideration should be given to:

1. Ratio of reservoir capacity to drainage area;
2. Reservoir shape;
3. Method of operation; and
4. Water retention time.

An initial step in estimating the quantity of sedimentation is a determination of the specific weight or density. The most important factors influencing density of sediment in a reservoir are:

1. Particle size;
2. Rate of compaction;
3. Possibility of flocculation; and
4. Mode of operation.

There are several other chemical and mechanical factors which may influence reservoir sedimentation but are felt to be beyond the scope of this study appendix.

Study Methodology

Trap efficiency was determined by the capacity-inflow method. In the initial step of determining specific weight (Lane and Koelzer, 1943) it was assumed that all reservoirs were to be the normally ponded type. Consideration was given not only to conservation storage for determining the capacity-inflow ratio, but the additional storage on up to maximum capacity was included.

Utilizing Burne's capacity-inflow ratio method (Trans., AGU, Vol. 34, 1953) to determine trap efficiencies, curves of trap efficiency versus reservoir capacity were made for the proposed sites, plate K4B.

The basic assumption for any individual reservoir was that in a given period a specific reservoir would entrap the percentage of total sediment inflow corresponding to the trap efficiency at a specific storage and the remainder would pass downstream. The given storage would be reduced by the volume of the sediment entrapped and the new storage would be the initial value for the next time period.

For a reservoir system the following procedure was used. The total annual sediment inflow at the upstream reservoir or reservoirs was subtracted from the total annual sediment inflow at the reservoir in question. To this base was added the sediment outflow from the upstream reservoir or reservoirs.

Curves of accumulated storage loss versus time were then constructed for each of the reservoirs and reservoir systems under consideration, plate K4B.

Conclusion

For the detailed design of recommended projects, deposition studies should be more intensive, especially if recreation and fish and wildlife are project purposes. Since the choice of recreational sites strictly on the basis of existing topography, could be disastrous, if consideration is not given to future reservoir deposition.

SUMMARY

Study results

For this attachment the area receiving prime consideration for bank erosion studies was the 110 mile reach of the Genesee River main stem from the Honeoye Creek confluence to the vicinity of Scio, New York.

Bank erosion studies for this area of the main stem revealed that:

1. A major bank stabilization project for the entire main stem was economically unjustified.

2. That portion of the river lying within Letchworth State Park, although sustaining considerable loss of bank material, does not lend itself to any feasible remedial project because of the deep gorge that the river passes through in this vicinity.

3. A dual purpose project, bank stabilization and flood prevention, for the 45 mile upstream reach from Portageville to the vicinity of Scio, although having a more favorable benefit-cost ratio, still did not appear to be justified.

4. On a smaller scale, a dual purpose project was studied for an area immediately below the existing Wellsville project through the town of Scio. The results of a preliminary economic analyses for a project which would provide protection against bank erosion and overbank flows for this 5 to 6 mile reach, indicated that further investigation was warrented. In contemplating further detailed studies for local protection in the Scio vicinity, consideration must be given to proposed upstream dams that may be recommended for construction. These upstream dams would substantially alter existing conditions in the town of Scio, and the dams probably would derive additional benefits for alleviating damages in this area.

5. Other localized problems near the villages of Belfast, Houghton and Fillmore should be included in any advance study.

Proposed Work

The New York State Department of Public Works has already investigated some bank stabilization in conjunction with highway protection for three separate locations in the Belfast vicinity as shown on plate K3B. Preliminary proposals include the use of groins

and revetment at the two upstream locations and the use of jacks at the third. Work would also necessitate some clearing and the excavation of a pilot channel.

The Commonwealth of Pennsylvania has recommended to the Director of Appalachian Studies that a stream bank stabilization project be considered along the West Branch of the Genesee River in Potter County. Proposed work would involve bank protection for a one mile stretch upstream from the village of Genesee at a probable cost of $80,000.

Tributaries

Problems on the tributaries are more localized in nature and it is felt that remedial measures will have to be taken by local authorities or individually. An exception is Canaseraga Creek which does have deposition due to overbank flooding but in many cases it is considered an asset rather than a detriment. Deposits provide rich soil for farming and ponded areas are used by waterfowl as nesting areas. The problem is one of removing this ponded water in time for spring planting and prevention of flooding during the growing season. A local protection project is being considered to resolve these problems.

Other

Depending upon the results of the final project and plan formulation for the Genesee River Basin, it would be advisable to extend and refine degradation and reservoir depositions studies. Also a subject for more detailed office and field investigations is to locate the source and determine what remedial measures might be taken to eliminate the large quantities of sediment reaching the mouth of the Genesee which require annual dredging to maintain a navigable harbor.

GLOSSARY

1. Aggradation - A depositional process that increases the elevation of a streambed in a specified reach relative to a previous elevation.

2. Alluvium - Recent deposits of sand, gravel or mud formed whereever the flow of current is checked in rivers or lakes.

3. Degradation - An erosional process that dcreases the elevation of a streambed in a specified reach relative to a previous elevation.

4. Dikes - Structures at an angle to the current.

5. Flocculation - Formation of aggregates by coalescence of small particles that are subjected to certain physico-chemical conditions.

6. Groin - Structures placed normal to the current or at a slight angle thereto.

7. Kellner Jack - Individual units composed of steel angle irons laced together with wire, pioneered by Kellner Jetties Corporation. When individual units are tied together, they form a permeable and extremely flexible jetty that readily conform to channel scour.

8. Lacustrine Deposit - Material deposited in a lake environment.

9. Lateral Migration - Movement of a river laterally across its valley.

10. Point Bar - A deposit formed on the inside, or convex side, of a river bend by lateral accretion.

11. Revetment - Structures parallel to the current of the realigned channel.

12. Scour - The enlargement of a flow section by the removal of material composing the boundary through the action of the fluid in motion.

13. Specific Gravity - Ratio of the mass of a body to the mass of an equal volume of water at a specified temperature.

REFERENCES CITED

1. Lane, E. W. and Koelzer, V.A., 1943, Density of Sediments Deposited in Reservoirs, Report No. 9, published University of Iowa, 60 p.

2. Tiffany, J. B., 1963, Review of Research on Channel Stabilization of the Mississippi River, 1931-1962, Comm. on Channel Stab. Tech. Report No. 2, 90 p.

3. U. S. Army Corps of Engineers, 1963, Potomac River Basin Report, v.VII, App. H. p. 49.

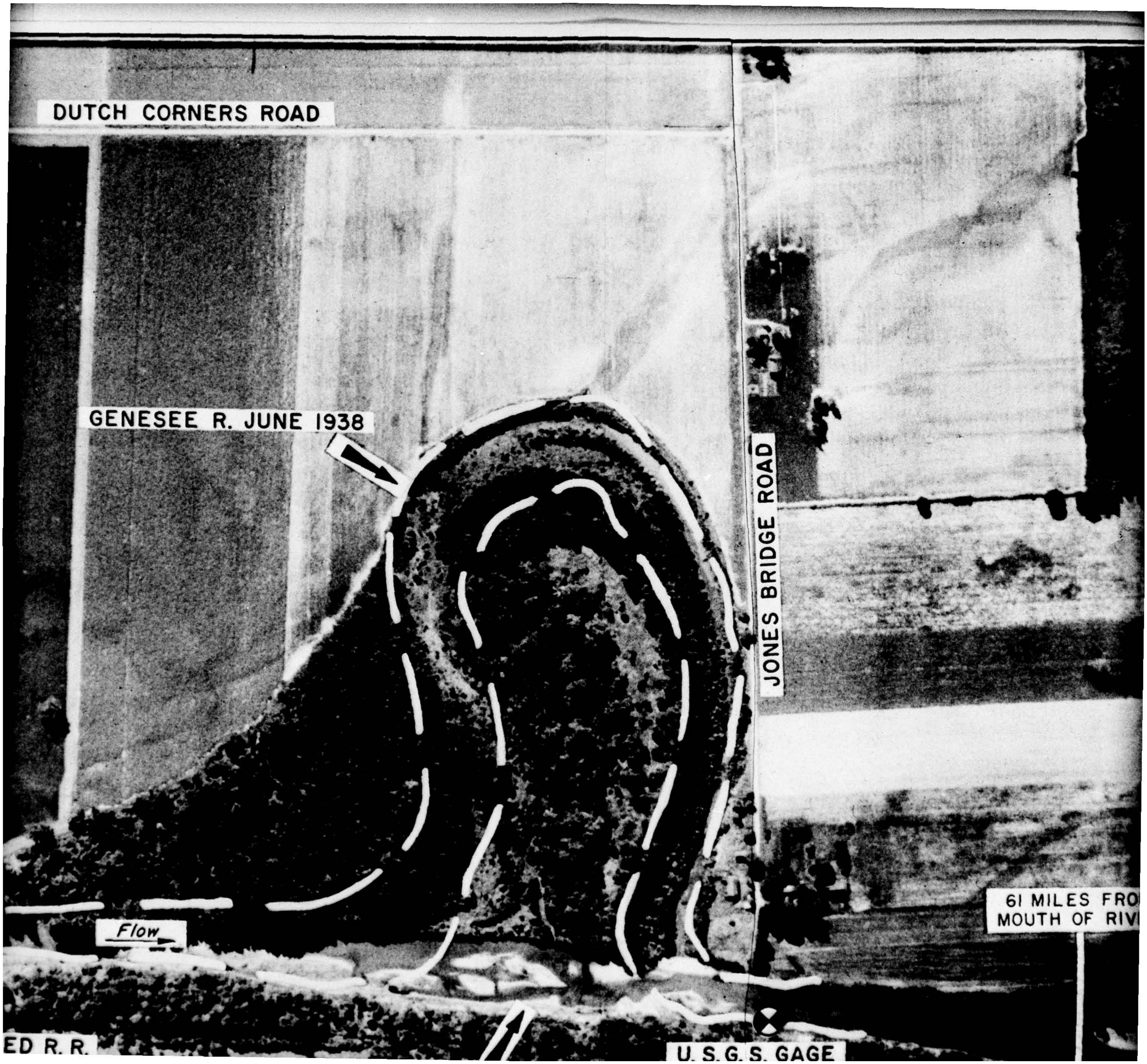
4. U. S. Army Corps of Engineers, 1963-66, Symposium of Channel Stabilization Problems, Comm. on Channel Stab. Tech. Report No. 1, v. 1-4.

5. U. S. Department of Agriculture, 1963, Proceedings of the Federal Inter-Agency Sedimentation Conference, Agricultural Research Service, Pub. No. 970, p. 185-590.

6. Wolff, R. G., and Benedict, P. C., 1964, Sedimentology, General Introduction and Definitions, U. S. Geo. Survey Open-file Report, 132 p.

7. Wolman, M. G., and Leopold, L. B., 1957, River Flood Plains: Some Observations on Their Formation, U. S. Geo. Survey Prof. Paper 282-C, p. 87-107.


DUTCH CORNER
GENESEE R
62 MILES FROM
MOUTH OF RIVER
Flow
CANASERAGA CR.
GENESEE RIVER
Flow
ABANDONED R. R.

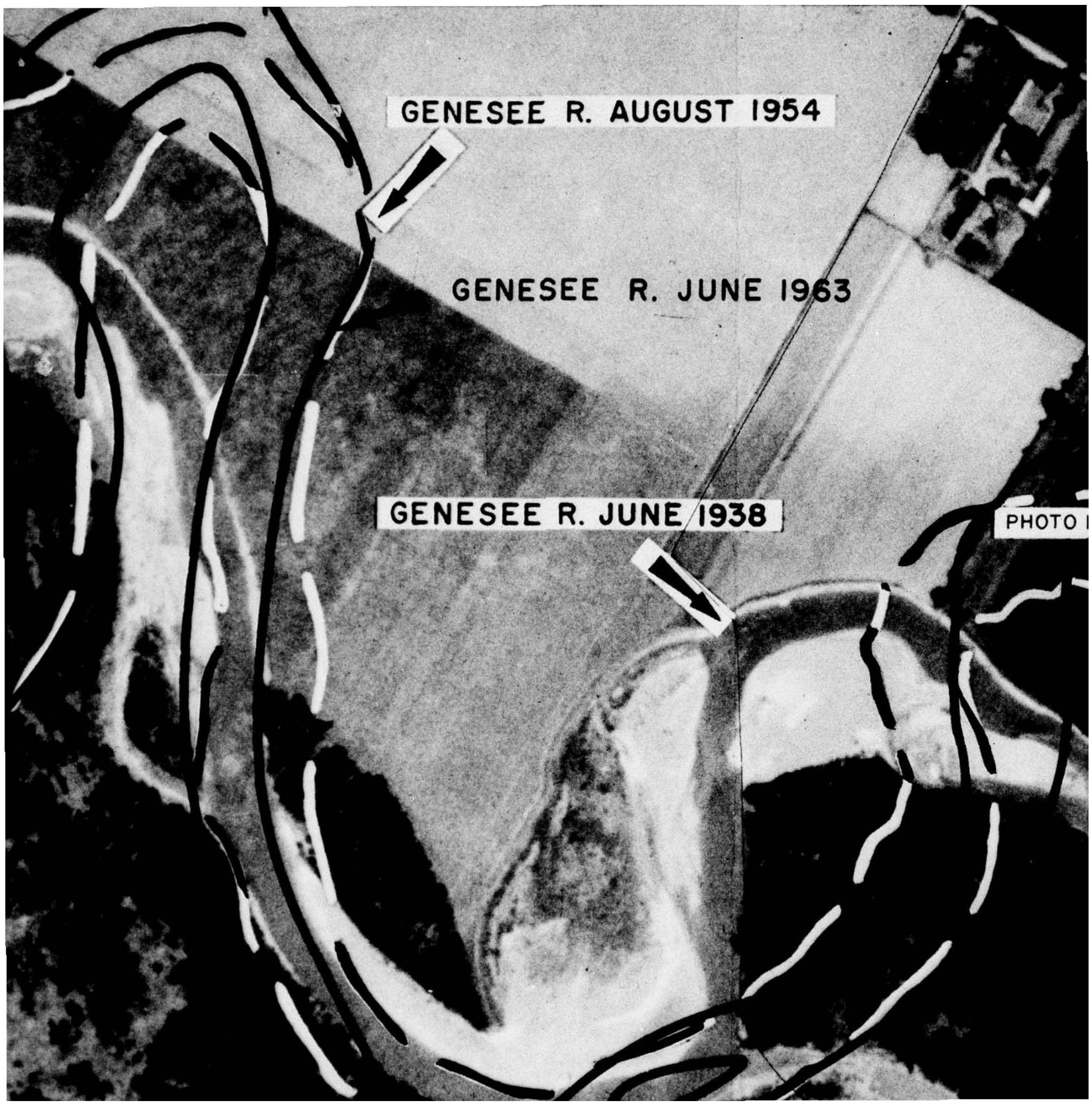


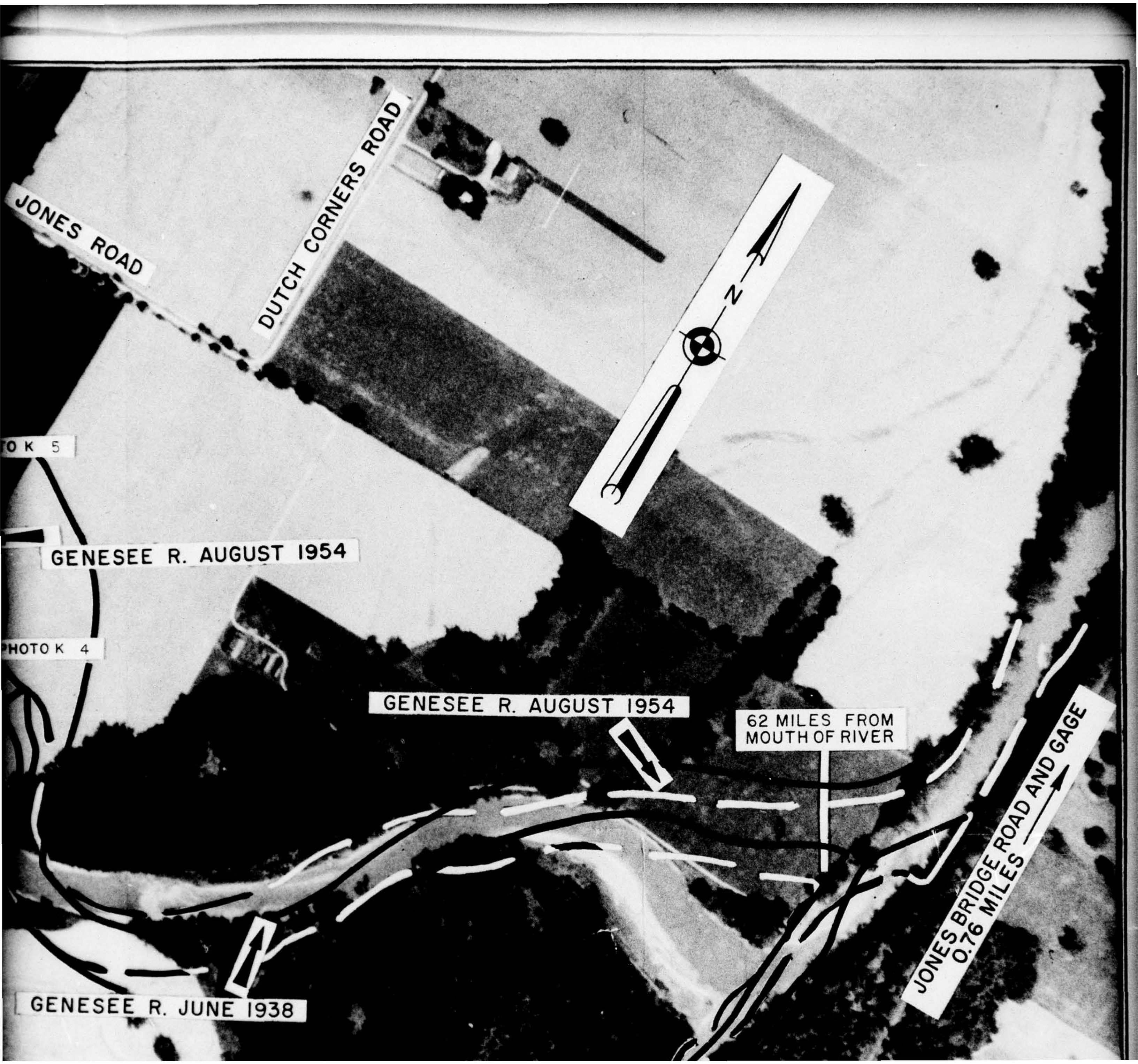
DUTCH CORNERS ROAD
GENESEE R. JUNE 1938
JONES BRIDGE ROAD
Flow
61 MILES FRO
MOUTH OF RIV
ED R. R.
U. S. G. S. GAGE


N
PHOTO K 2
ROUTE 20A
PHOTO K I
MILES FROM
UTH OF RIVER
PHOTO K 3
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
CHANNEL ALINEMENT
CHANGE, 1938-1954
CORPS OF ENGINEERS BUFFALO, NEW YORK
JUNE 1967

3

PLATE KIB


GENESEE R. AUGUST 1954
GENESEE R. JUNE 1963
GENESEE R. JUNE 1938
PHOTO I

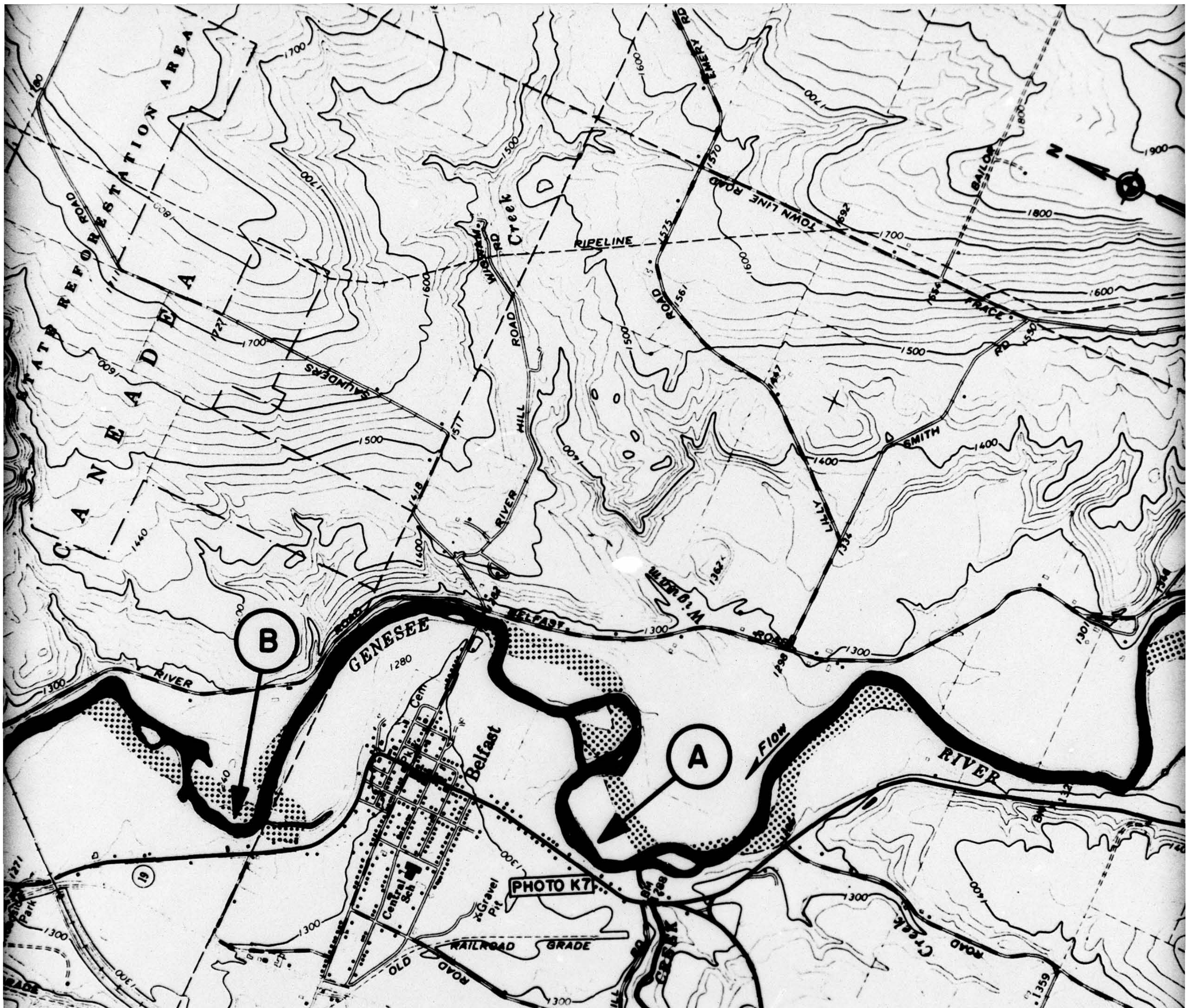


JONES ROAD
DUTCH CORNERS ROAD
N
TO K 5
GENESEE R. AUGUST 1954
PHOTO K 4
GENESEE R. AUGUST 1954
62 MILES FROM
MOUTH OF RIVER
JONES BRIDGE ROAD AND GAGE
0.76 MILES
GENESEE R. JUNE 1938

GENESEE
RIVER
Flow
Houghton
Houghton College Airfield
Shongo
Caneadea
CANEADEA
ERIE-LACKAWANNA
PIPELINE
FOX HILL ROAD
CREEK
MILL STREET

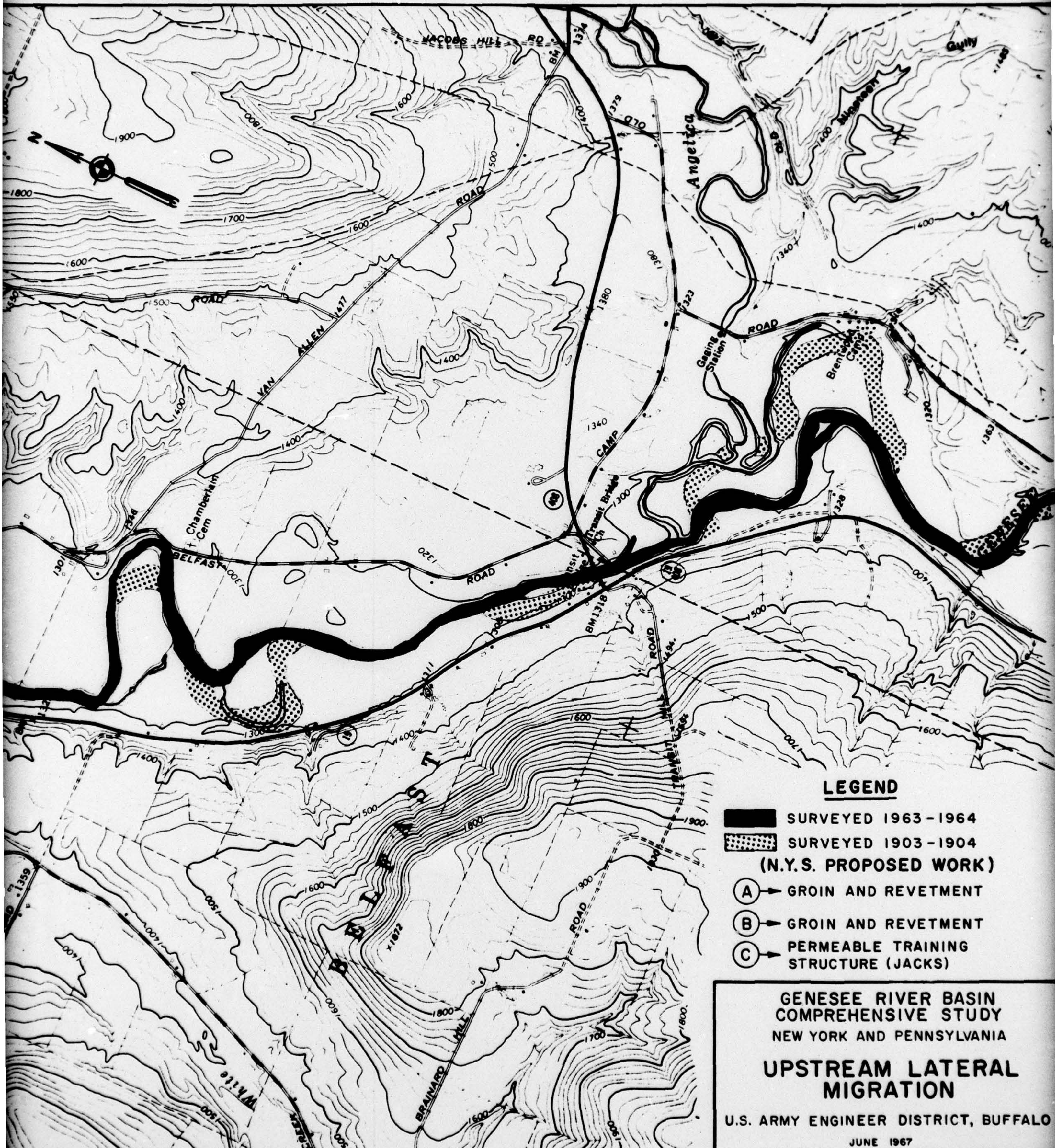
PIPELINE
JEEP
STATE REFORESTATION AREA
CANEADEA
PINKERTON ROAD
EAST HILL ROAD
ORAMEL HILL ROAD
ERIE-LACKAWANNA
C
EAST RIVER ROAD
E RIVER RD
PHOTO K8
GENESEE RIVER
Cem.
Oramel
(BM 1256)
Caneadea
GENESEE VALLEY CANAL
RAILROAD GRADE
CREEK
STREET
HILL
Roadside Park
1000
0
1000
2000
3000

2



CANEADEA STATE REFORESTATION AREA
GENESEE RIVER
Belfast
Central Sch
PHOTO K7
Flow
A
B
RIPELINE
TOWN LINE ROAD
SAUNDERS
RIVER ROAD
HILL
BELFAST ROAD
SMITH RD
LILLY
EMERY RD
BAILOR
OLD RAILROAD GRADE
NEW ROAD
GENESEE VALLEY CANAL
GLEASON HILL RD
BLACK CREEK
HUGHES
LITTLE
xGravel Pit
1 MILE
1000 2000 3000 4000 5000 6000 7000 FEET

3

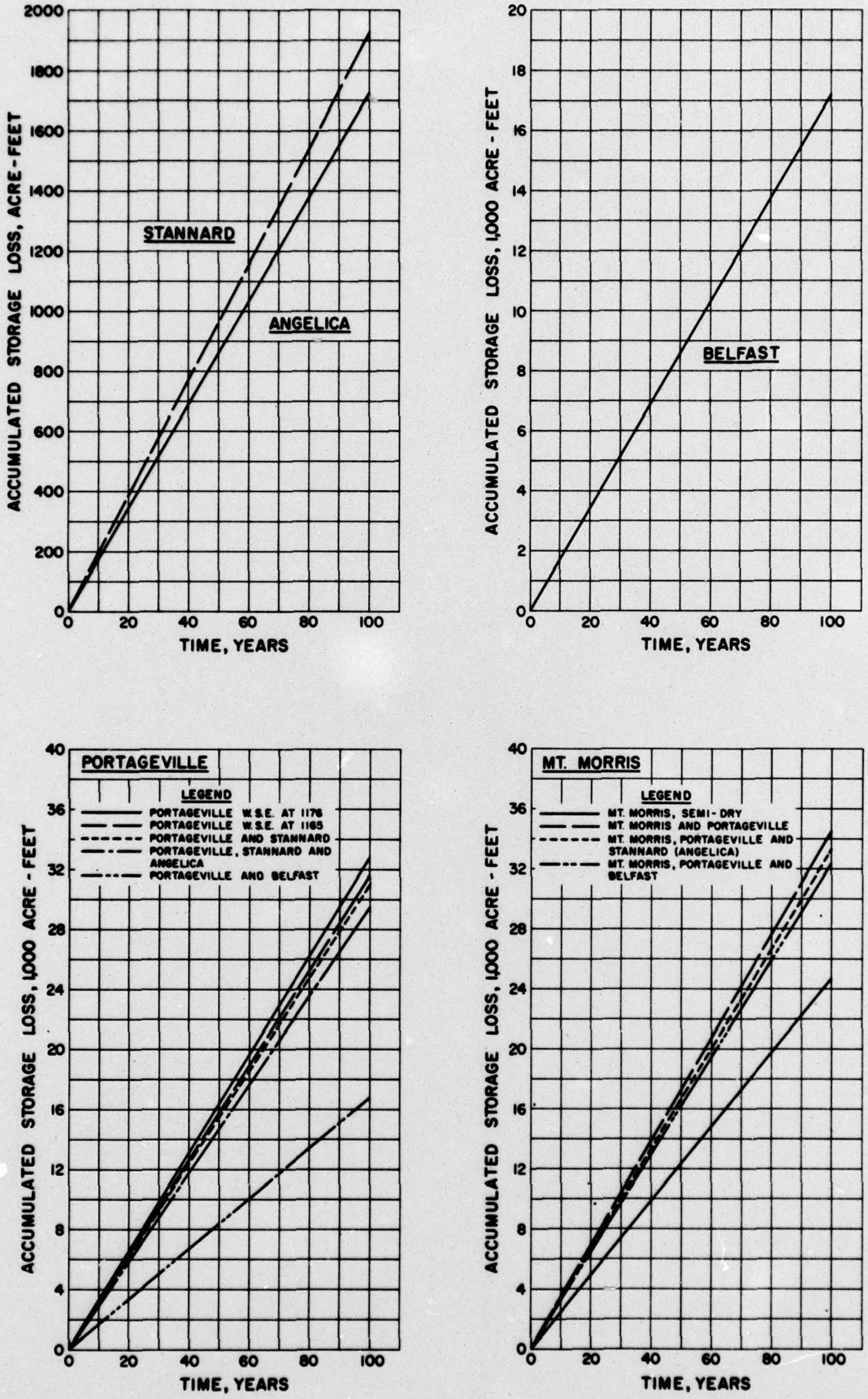


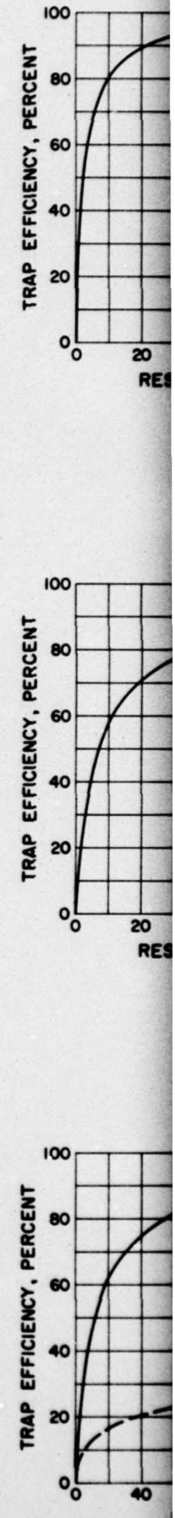
LEGEND
SURVEYED 1963-1964
SURVEYED 1903-1904
(N.Y.S. PROPOSED WORK)
A GROIN AND REVETMENT
B GROIN AND REVETMENT
C PERMEABLE TRAINING STRUCTURE (JACKS)
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
UPSTREAM LATERAL MIGRATION
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967
JACOBS HILL RD
Angelica
ROAD
VAN ALLEN
BELFAST
CAMP
Chamberlain Cem
Gaging Station
BELFAST
BRAINARD HILL
White
CREEK

PLATE K3

4

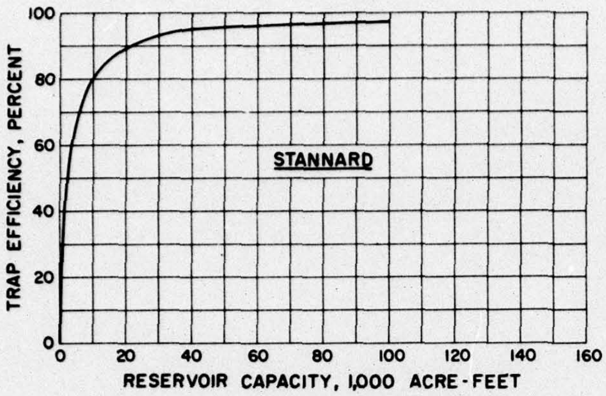
STORAGE LOSS VS TIME

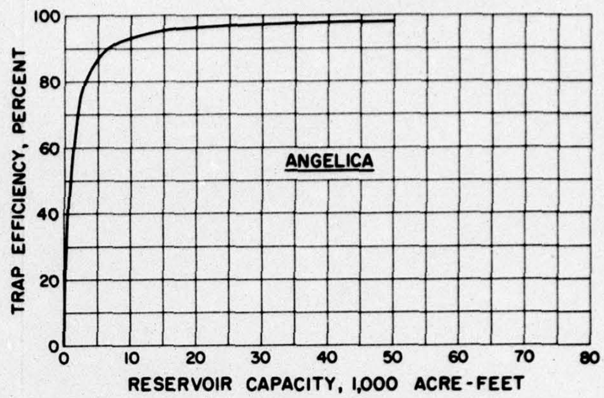


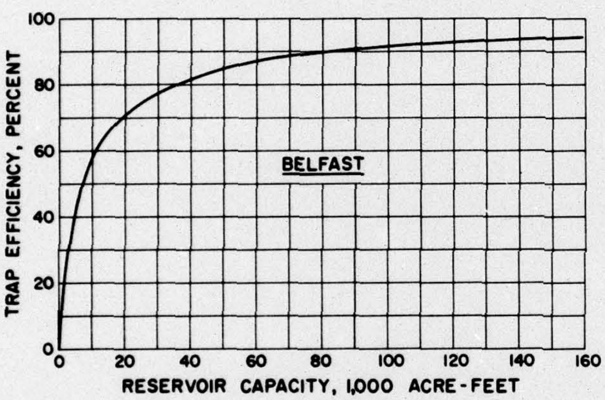


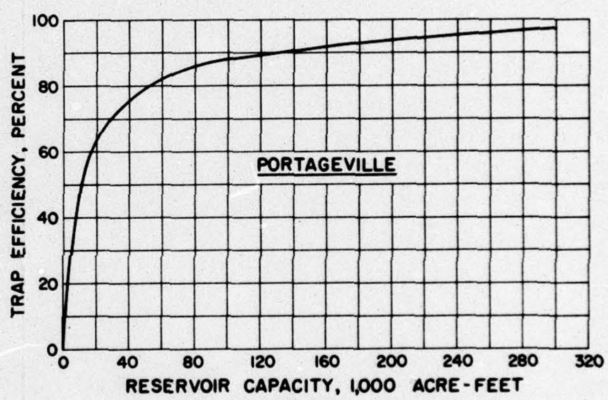
2

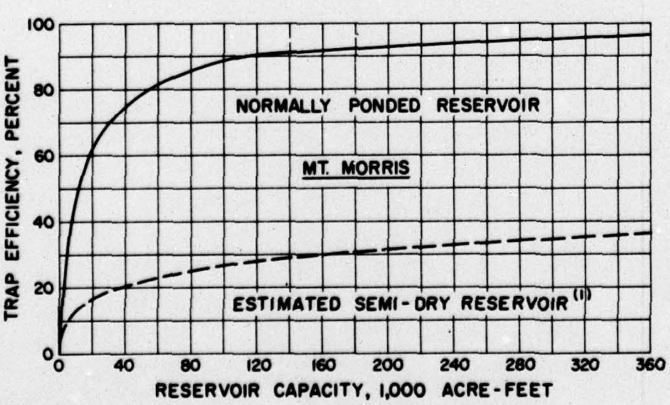
TRAP EFFICIENCY VS RESERVOIR CAPACITY











NOTE

1. EXISTING METHOD OF OPERATION FOR MOUNT MORRIS RESERVOIR.

GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA

RESERVOIR SEDIMENTATION CURVES

U. S. ARMY ENGINEER DISTRICT, BUFFALO

JUNE 1967

PLATE K48

ATTACHMENT C FOR APPENDIX K (SEDIMENTATION)

of

GENESEE RIVER BASIN COMPREHENSIVE STUDY

Sheet and Channel

Erosion in the Uplands

Prepared By

U.S. Department of Agriculture

1967

CONTENTS

TABLES

SHEET AND CHANNEL EROSION IN THE UPLANDS

SUMMARY

Soil losses in the uplands of the Genesee River Basin were computed on a composite acre basis by soil associations. These losses were less than 3.0 tons per acre which is considered allowable by the U.S. Soil Conservation Service. Channel erosion, including streambank and streambed, do occur in the uplands but mainly to low value land making protection unjustifiable on a watershed basis.

Required sediment storage for reservoirs is 0.27 acre feet per square mile per year. This figure was derived by estimating the soil losses in the basin and considering a limited number of reservoir sediment surveys. It is not considered to be a critical loss of storage.

SCOPE

The Soil Conservation Service was given the responsibility of studying sheet and channel erosion in the upland areas. This report summarizes these studies and is intended to be an attachment to Appendix K - Sedimentation.

Occurrences and effects of sheet erosion, resulting from uniform overland flow of water, and channel erosion, resulting from concentrated flow, were investigated and evaluated. Sediment quantities produced by these processes and delivered to potential reservoir storage sites were calculated through the use of empirical equations. Actual amounts of sediment in existing reservoirs in the area were evaluated, and compared favorably with results obtained from use of the empirical formula.

As a result of these investigations, the importance of these erosional processes was evaluated and plans for future work can be developed.

EROSION IN UPLANDS

INTRODUCTION

In the "Upland" areas of the Basin (i.e., those outside of the flood plain and main valley of the Genesee River itself), erosion was studied from several aspects:

1. Erosion as a direct cause of damage.
2. Erosion as a source of damage through deposition of sediment.
3. Erosion as a source of sediment that would occupy space in water storage reservoirs.

The first two aspects are discussed in the Appendix J, "Agricultural Studies". The last aspect is the subject of this particular phase of the study.

Method of Study

By use of the Universal Soil Loss Prediction equation, erosion rates in terms of tons per acre per year were obtained and applied to each site. Parameters of this equation include rainfall duration and intensity, erodibility of soil types, vegetative cover, cropping practices, land slopes and slope lengths. A composite acre representing the relative proportions of each type of land use, i.e., forest, idle, pasture, cropland, and other land, was developed for each soil association.

Sources of Sediment

Sheet Erosion

Numerous individual soil types are present in the basin. By grouping similar soils into associations, an overall picture of erosion rates can be obtained with little reduction in the accuracy of the estimate of soil loss.

Twenty-four soil associations occur in the Genesee River Basin. Six of these are composed mainly of fine-grained materials and are very susceptible to erosion. An example of an easily eroded soil group is the Caneadea-Canaseraga Association with an estimated rate of soil loss of between 1.96-2.31 tons per acre per year. Coarser textured soils such as the Chenango-Tioga Association are more difficult to erode and have erosion rates estimated at between 0.39 and 0.77 tons per acre per year. Both examples are based on present conditions.

Table I shows estimated soil loss rates computed by the Universal Soil Loss Prediction equation for each soil association using the appropriate composite acre.

Cover conditions have a direct influence on the amount of soil which is susceptible to erosion. Where a row crop such as corn is planted much of the soil is exposed to the impact of raindrops and runoff water. Grass on the other hand covers most of the soil and the extensive root system and surface covering holds the soil in place as well as absorbs the force of the rain. The better the cover, the less the resulting erosion.

Due mainly to the large areas of forest and grasslands in the basin, the estimated gross erosion rates shown in Table 1 are less than 3.0 tons per acre. The Soil Conservation Service considers the maximum allowable soil loss rate to be 3.0 tons per acre per year for the soils in the basin area under optimum conservation practice conditions.

Upon consideration of the basin land use, cover and soils conditions, and the results of gross erosion estimates as shown in Table 1, indications are that sheet erosion is not a major problem at the present time. It should be noted, however, that severe sheet erosion rates may periodically develop in relatively small local areas.

In the future, when urban and agricultural development areas increase or change to more row crop production, erosion rates are expected to increase based on the new, more intensive use of the land. This will be true especially where highly erodible soils occur in parts of Genesee, Livingston and Monroe Counties.

Channel Erosion

Channel erosion also contributes to the amount of sediment in streams. Channel erosion is usually separated into streambank erosion and stream bed erosion. Streambank erosion is usually most noticeable at outside bends where the water is undercutting the streambank. Naturally, all of the material eroded here falls into the stream. However, not all is delivered to a downstream site. Some sediment is deposited on the inside of the stream meanders while other larger material is only moved by the stream during flood flows. Although there are no studies which show or confirm the relationship between the amount of sediment from sheet erosion as compared to sediment from channel erosion delivered to a site, it is estimated that 25 percent of the total delivered is derived from channel erosion.

In most cases, streambank erosion in the upland areas occurs to low value land which is either in grass or woods; this is primarily a nuisance damage. Cost for protecting such land is considered to be in excess of the present value of the land, therefore, protection is not presently justifiable. Protection is needed locally where buildings are being undercut by streambank erosion, but these situations are minor and should be handled by local interests.

Stream bed erosion is not prominent in the Basin with the exception of some steep gradient streams. Here down-cutting occurs as a result of higher velocity flows. On streams of a flatter gradient, the bedload acts as a protective layer shielding the stream bottom from all but the higher velocity flows. When this bedload armour is moved by flood flows the stream bottom is exposed to the erosive force of the excessive flows of water. In general, not much sediment is believed to come from stream bed erosion.

Flood plain scour contributes some sediment to the streams in the Basin, but occurrences of scour are few in number. Here again the amount of sediment from this source is negligible.

RESERVOIR SEDIMENTATION

A sediment storage requirement of 0.27 acre feet per square mile of drainage area per year was estimated for the entire Basin. This amounts to 350 tons per square mile per year, based on a limited number of reservoir sediment surveys in the area and Soil Loss Predictions (see Tables 1 and 2). Throughout the Basin this value appears to be fairly accurate, but in some cases local conditions will alter the figure. Water storage loss in reservoirs can be planned for by using this figure. This is not considered to be an excessive loss of storage.

In deriving this factor, the reservoirs were assumed to have a trap efficiency of 90 percent, based on the ratio of the capacity of the dam to the amount of in-flow into the site. In most cases, this ratio will be about 0.15, which is 90 percent trap efficiency. The higher the ratio, the more sediment will be trapped. At 90 percent efficiency not all of the material is trapped; some remains in suspension and passes through the dam with the outflowing water.

Average submerged sediment in nearby reservoirs is about 80 pounds per cubic foot. This figure was assumed to be valid for the studies in the Basin.

TABLE NO. 1

SOME TYPICAL SOIL LOSS ESTIMATES*

Subwatershed	Soil Association**	Gross Erosion (Tons/Acre/Year)	Natural Source Material
5	Lordstown-Volusia-Mardin	1.40	Shaley till
5	Volusia-Mardin-Lordstown	1.43	Till
5	Chenango-Tioga	0.77	Outwash & alluvium
5	Oquaga-Lackawanna	0.83	Reddish till
5	Caneadea-Canaseraga	2.31	Fine-grain lakebeds
6	Lordstown-Volusia-Mardin	1.22	Shaley till
6	Chenango-Tioga	0.39	Outwash & alluvium
6	Caneadea-Canaseraga	1.96	Fine-grain lakebeds
7	Volusia-Mardin-Lordstown	1.02	Till
7	Caneadea-Canaseraga	2.02	Fine-grain lakebeds
8	Lordstown-Volusia-Mardin	1.09	Shaley till
8	Volusia-Mardin-Lordstown	1.26	Till
8	Caneadea-Canaseraga	2.38	Fine-grain lakebeds
9	Volusia-Mardin-Lordstown	1.33	Till
9	Chenango-Tioga	0.61	Outwash & alluvium
9	Bath-Chenango	0.77	Till & gravel outwash
10	Volusia-Mardin-Lordstown	1.03	Till
10	Caneadea-Canaseraga	2.18	Fine-grain lakebeds
10	Bath-Chenango	0.92	Till & gravel outwash
10	Erie-Langford	1.27	Till
11	Bath-Chenango	1.44	Till & gravel outwash
11	Erie-Langford	0.66	Till
11	Langford-Erie	0.69	Glacial till
17	Odessa-Schoharie	1.65	Reddish till & lakebeds
17	Lansing-Conesus	1.91	Glacial till
18	Bath-Chenango	1.28	Till & outwash
19	Ontario-Hilton	1.24	Reddish lime till
20	Odessa-Schoharie	0.74	Reddish till and lakebeds
20	Ontario-Hilton	0.82	Reddish lime till

* Based on a composite acre

** The order of soil types included in each association, e. g. Lordstown-Volusia-Mardin, usually shows the dominant soil type in the leading position. The variability of both land use and dominant soil type are chiefly responsible for the differences between estimates of rates of gross erosion shown for subwatersheds having the same soil associations.

TABLE NO. 2 - SEDIMENT ACCUMULATION IN EXISTING IMPOUNDMENTS

Name & Location	Drainage Area (Square Miles)	Sedimentation Rates: Years of Records	Sedimentation Rates: Ac.Ft./Sq.Mi./Yr.	Sedimentation Rates: Ton/Sq.Mi./Yr.	Assumed Lbs./Cu.Ft.
Rushford Lake Caneadea Creek SWS-9	60.7	26	.37	484	60
Orchard Park Reservoir Trib. Cazenovia Cr. Buffalo Creek Watershed	1.67	23	.23	300	60
Pylkas Dam Dean Creek Spencer, N.Y.	1.1	11	.025	63	80
Pelto Dam Dean Creek Spencer, N.Y.	.3	11	.112	229	79.2*

* Actual Measurement